

# כימיה בישראל CHEMISTRY IN ISRAEL



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David Ben-Gurion, the first Prime Minister of the State of Israel, addressing the Annual Meeting of the Israel Chemical Society, in 1963, after receiving an Honorary Membership in the Society. This was the first time that a Scientific Meeting was held in the city of Beer-Sheva. On his left are Professors Felix Bergmann, Shalom Sarel (the President of the Society at the time) and Ernest David Bergmann.



# כימיה בישראל - בטאון החברה הישראלית לכימיה

<http://www.weizmann.ac.il/ICS>

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בתמונת השער נראה דוד בן-גוריון נואם בפני הכינוס השנתי של החברה הישראלית לכימיה, בשנת 1963. כינוס זה היה הכינוס המדעי הראשון שנערך בעיר באר-שבע.

הכינוס של החברה השנה היה ה-70 במספר. נשיא החברה, פרופ' שמאי שפייר, קידם בכרכה את כל הנשיאים לשעבר שהגיעו לכינוס והזמין את פרופ' שלום שראל, שהיה הנשיא הראשון של החברה, במתכונתה הנוכחית, לשאת את דברו. פרופ' שראל העלה על נס את השנויים שחלו בארץ בתחום הכימיה מאז הימים ההם, כשלא היה כמעט כלום בתעשייה ובמחקר הכימי, ועד לימינו אלה, שישראל מוכרת כמעצמה בתחום הכימיה והמדע בכלל.

בדווח על הכינוס השנה, מובאת תמונה מן הכינוס בשנת 1963, שבה נראה פרופ' שראל מעניק תעודת חברות כבוד לדוד בן-גוריון.

למדנו בבית הספר שהגזים האצילים אינם מתחברים עם אלמנטים אחרים. מסתבר שזה לא בדיוק נכון, וכיום ישנה התחדשות בכימיה של גזים אצילים. פרופ' בני גרבר, הידוע כסמכות עולמית בדינמיקה מולקולרית, גילה מתוך חישובים קוואנטום מכניים שאכן ישנה אפשרות לקיום מולקולות מסוימות ואפילו פולימרים (קטנים) המכילים גזים אצילים ופחמן. בעקבות פרסומי סונטאו בשתי מעבדות בעולם, באופן בתי תלוי, תרכובת דוגמת  $\text{HXeCCH}$ . על הישגיו בתחום הדינמיקה המולקולרית והכימיה החדשה של גזים אצילים, הוענק השנה פרס החברה הישראלית לכימיה לפרופ' בני גרבר, ומאמר על עבודתו מובא בגליון זה.

גזים אצילים יכולים גם להיספח על פני שטח סיליקון מסוים וליצור שכבת ביניים שעליה אפשר לבנות בשיטות ליטוגרפיות הדפסים מוגדרים. היות ואנרגיית הספיחה של הגזים האצילים נמוכה מאד ניתן בקלות לדפסם וכך ליצור חוטי מתכת מוליכים ברוחב קטן, עד כדי 30 ננומטר, ואורך רצוי. הירחון המדעי הנפוץ Scientific American פרסם לאחרונה רשימה של 50 מדענים שעבודתם היתה בעלת משמעות טכנולוגית מיוחדת, וביניהם היה גם פרופ' מיכה אשר, מהאוניברסיטה העברית, שמאמר על עבודתו מובא בזה.

השנה מלאו 50 שנה מאז פרסם מאמר קצר ב JACS שהכניס את המושג "Living Polymers" לעולם הפולימרים הסינטיטיים. עיקרו מניעה או שליטה על ריאקציות הטרימיניות, הקיימת בכל שיטת פולימריזציה. העבודה הראשונה היתה בפולימריזציה אניונית, אבל ההתפתחות כיום כוללת את רוב שיטות הפלמור, ומצליחה לסנתז פולימרים בעלי משקל מולקולרי אחיד, ובלוק פולימרים שמאפשרים מורפולוגיות ומקור-מיבנים מאד מעניינים. פרופ' משה לוי ממכון ויצמן, מתאר במאמרו כמה מן ההתפתחויות הייחודיות בתחום.

אחת ממטרותיה המוצהרות של החברה היא קידום הוראת הכימיה בארץ. פרופ' ארנון שני עוקב אחרי מצב רישום סטודנטים לכימיה באוניברסיטאות ודן בהיבטים של היצע וביקוש ושמירה על רמה גבוהה.

הפקולטה לכימיה של הטכניון בשיתוף עם החברה ממשיכה את מפעל "הכימאדה" השנתי לעידוד לימודי הכימיה בתיכון. מימד כמותי להצלחה הוא בעובדה שמספר המשתתפים במבחן הראשון השנה עלה ב-40% לעומת השנה שעברה, עד ל-2155 תלמידים.

את ההצלחה בהתעניינות במקצוע יש לזקוף בראש וראשונה למורי הכימיה. ואומנם המסורת שהונהגה בשנה האחרונה נמשכת והשנה הוענק פרס המורה המצטיינת לדלית אביגד, מבית הספר התיכון כדורי. כמו כן הוענקו פרסים לתלמידים מצטיינים.

ד"ר בוב וינטרוב, מהמכללה להנדסה ע"ש סמי שמעון בבאר-שבע ואשדוד, דלה כמנהגו מן הארכיון עוד סיפור מעניין. הפעם סיפורו האישי והמדעי של חתן פרס נובל George de Hevesy. מדען גדול זה פתח עבורנו את תחום המעקב על ידי איזוטופים רדיואקטיביים במערכות כימיות וביולוגיות ואיפשר לנו לגלות עולמות נסתרים.

פרופ' חוה ליפשיץ, מהאוניברסיטה העברית, שקבלה את פרס החברה לשנת 2003, נפטרה לאחר מחלה קשה. דברים לזכרה מובאים בגליון זה.

# התיצבות במספר הלומדים כימיה במוסדות להשכלה גבוהה

אורון שוי, המחלקה לכימיה אוניברסיטת בן-גוריון בנגב, באר שבע

לאחר מספר שנים של עליה משמעותית ביותר במספר הנרשמים והלומדים בפועל את למודי הכימיה באוניברסיטאות חלה התיצבות במספר הסטודנטים לכימיה. בשנת תשס"ב חלה עליה ב- 30% במספר הלומדים כימיה באוניברסיטאות [ראה: "תאם חל מפנה בהרשמה לכימיה באוניברסיטאות? כימיה בישראל גליון 8 (טבת תשס"ב), עמוד 30]. במשך מספר שנים חלה עליה נוספת במספר התלמידים החדשים ומכאן, בכלל התלמידים לתאר ראשון. בהמשך, כצפוי, התבטא הדבר גם בלמודי תארים מתקדמים, כפי שניתן לראות בטבלה מס. 1.

טבלה מס. 1. מספר הלומדים כימיה בשנים תשס"ב-תשס"ה

שנה	מספר	מספר	מספר	מספר	מספר
423	-----	268	-----	1063	406
441	65	312	137	1238	527
467	80	391	157	1590	672
493	75	435	190	1698	502

פרוט מספרי הלומדים לפי מוסדות ניתן לראות בטבלה מס. 2. ניתן להניח כי שני גורמים פעלו וגרמו להתיצבות:  
א. יכולת הקליטה של המחלקות השונות הגיעה לשיאה, מאחר ומספר העמדות במעבדות החוראה הוא קבוע ומספר ימי הלימוד בשבוע גם הוא מוגבל ל- 6 ימי לימוד - הרי אין אפשרות לקלוט תלמידים נוספים.  
ב. על מנת לשמור על הרמה הגבוהה של התלמידים אליה הגענו, מקפידים לא להנמיך את סף הקבלה.  
אני הייתי מוסיף נמוך לא פחות חשוב, עליו עמדתי ברשימה הקודמת בנושא [ראה: "עד כמה רצוי הגידול במספר הלומדים כימיה באוניברסיטאות? כימיה בישראל גליון 15, עמוד 31] - שמירה על אזור נאות בין ההצע והביקוש. כלומר, לא להציף את שוק העבודה בעודפי כימאים, על מנת למנוע נפילה ברמות השכר של הכימאים בדרגים השונים, ועל מנת להעלות את ערך הכימאים בעיני עצמם ובעיני האחרים.

טבלה מס. 2. מספר הלומדים כימיה במוסדות להשכלה גבוהה בשנת הלימודים תשס"ה (2004/5)

(51)	61	(6)	2	(67)	65	(22)	20	(377)	432*	(130)	104*
(74)	74	(10)	9	(55)	65	(31)	32	(440)	435	(231)	121
(61)	65	(11)	15	(60)	56	(22)	21	(254)	284	(104)	93
(99)	101	(13)	7	(96)	121	(44)	61	(285)	299	(117)	103
(28)	29	(6)	4	(36)	52	(13)	22	-----	-----	-----	-----
(33)	42	(3)	7	(25)	28	(6)	9	(234)	248	(90)	81
(121)	121	(31)	31	(52)	48	(19)	25	-----	-----	-----	-----
(467)	493	(80)	75	(391)	435	(157)	190	(1590)	1698	(672)	502

המספרים בסוגריים הם נתוני הלומדים בשנת תשס"ד.  
\* כולל שלשה מסלולים: כימיה, ביוכימיה מולקולרית ומסלול משולב כימיה-הנדסת חומרים.

בחינת מודעות "דרושים" בשוק העבודה מלמדת כי יש ביקוש רב לכימאים ברמות השונות, החל מטכנאי/הנדסאי עד בעלי תואר דוקטור לתפקידים רבים ומגוונים. החשוב הוא כי מגוון ההצעות מתפרס החל מהתחומים הקלסיים של מעבדות אנליטיות, בקרת טיב, סינתזה, מחקר ופתוח וכלה בתפקידים הקשורים במידע, פתוח שווקים, קנין רוחני ועוד. עם פתוח תחומי הביוטכנולוגיה והטכנולוגיות המתקדמות האחרות אין ספק שמקומם של הכימאים בתחומים חדשניים אלה רק יתרחב ויתפתח. אל נא נאכזב את הגורמים התעשייתיים התולים תקוות רבות בכימאים. נכשיר אותם ברמה הגבוהה ביותר עם יכולת התאמה לתפקידים השונים המוצעים להם. יכולת עבודה בצוות, יצירתיות, מקוריות וגישות בלתי שגרתיות לפתרון בעיות הם הנכסים החשובים ביותר של הבוגרים ועלינו לפתח כשורים אלה מבלי לפגע במוטיבציות החיוביות שיש להם.

# תחרות ה"כימיאדה" השמינית לשנת תשס"ה (2004/5)

חירה כ"ץ, הפקולטה לכימיה, הטכניון

האולימפיאדה הארצית לכימיה לתלמידי כיתות י"א - י"ב בבתי-הספר התיכוניים, שהיא השמינית בסדרות התחרויות, מתקיימת זו השנה השישית, בפקולטה לכימיה בקרית הטכניון, בשיתוף החברה הישראלית לכימיה, בעידוד ובתמיכת המחלקה לנוער שוחר מדע במשרד החינוך.

למרות שה"כימיאדה" מיועדת בעיקר לתלמידים של כיתות י"א - י"ב, כל שנה משתתפים בה, בהמלצת בתי-הספר, מספר תלמידים מכיתות ח' - י'. אשתקד עלו לגמר וזכו במקומות הראשונים שני התלמידים טל פריצקר (י') ודן דבירי (ט') שאוותרו ב"כימיאדה" 2003/4. תלמידים אלה נמצאים בקשר רציף עם פרופ' גבי קוונצל, האחראי האקדמי בפקולטה על ה"כימיאדה", ולומדים בתוכנית מותאמת אישית, בפקולטה לכימיה בטכניון, לאורך כל השנה.

## ה"כימיאדה" מתקיימת בשלושה שלבים:

### שלב א' - 9.11.2004

מבחן המיון הראשוני התקיים באותו יום ובאותה שעה, בכל בתי - הספר המשתתפים בתחרות, ונבדק בטכניון. השנה נגשו ונבחנו בפועל בשלב א' 2155 תלמידים - גידול של 44% מהשנה שעברה. בשלב זה השתתפו בפועל 139 בתי - ספר מכל רחבי הארץ - גידול של 29% מהשנה שעברה.

### שלב ב' - 8.12.2004

התקיים בטכניון בפקולטה לכימיה.

מתוך 2155 תלמידים שהשתתפו בפועל בשלב א' עלו לשלב ב' 174 תלמידים.

מתוך 139 בתי-ספר שהשתתפו בשלב א' עלו לשלב ב' 77 בתי-ספר.

דברי פתיחה וברכות ניתנו על ידי פרופ' גבי קוונצל, האחראי האקדמי על ה"כימיאדה"; גב' ריבי לקריץ, מנהלת המחלקה לנוער שוחר מדע, ברכה בשם משרד החינוך, פרופ' אורי פסקין סגן דקן לענייני תוראה, כרך מטעם הטכניון.

בשלב זה התלמידים נבחנו בכתב (3 שעות). הבחינה כללה 5 שאלות והכילה חומר שלא נלמד בבית - הספר. בשלב זה הושם הדגש על דרך החשיבה המדעית של התלמיד ולא רק הידע.

המשתתפים שמעו הרצאה מפי פרופ' אורי פסקין על תחומים חדשים בכימיה, שלוותה בהדגמות בעזרתה של הגב' אמה גרץ, בנושא: "מהפכת הטכנולוגיות הכימיות".

התלמידים ערכו סיור מודרך בליווי הסברים של כשעתיים במעבדות מחקר של חברי סגל.

שלב זה התקיים כארוע מדעי ותגובות התלמידים היו נלהבות. הגיעו פניות מבתי-ספר המבקשים להשתתף כאורחים וצופים בשלב זה.

### שלב ג' - 13-14.4.2005

יתקים עם תחילת חופשת הפסח לפני החג.

החווייה המסמנת את הצלחת ה"כימיאדה" היא שהשנה נגשו בשנית לבחינות תלמידים שהיו אשתקד בכתה י"א. הם ספרו לנו שמאוד נהנו בשנה שעברה וזו הייתה עבורם חוויה לימודית מרשימה, ולמרות העומס של הלימודים ובחינות הבגרות הם נגשו לבחינות ה"כימיאדה" גם השנה.

## **פרס החברה הישראלית לכימיה למורה המצטיינת**

לשנת תשס"ד מוענק

### **לגבי דלית אביגד**

בית-הספר התיכון כדורי

לפני כחמש שנים דלית אביגד סיימה את לימודי התואר השני בהוראת הכימיה בטכניון, במקביל להוראת הכימיה בבית הספר התיכון כדורי, תוך כדי הצלחה בתפקידים מקצועיים מרכזיים בבית-הספר. במקביל לעבודתה הנמרצת כמורה לכימיה, הפכה דלית לרכזת לימודי הכימיה בבית-ספרה ולמדריכה מחוזית לכימיה באזור הצפון. בכך תרמה רבות לקידום ולפיתוח מקצועי של מורי הכימיה במחוז הצפון. בהתלהבותה, ארגנה בהצלחה, בשיתוף עם מכללת עמק-הירדן ועם המרכז הארצי למורי הכימיה, כנס למורי כימיה בכינרת, כנס אשר השאיר חותמו על המורים. אהבתה הגדולה לכימיה, ידיעותיה הרחבות והדרך המקצועית בה היא מלמדת תוך התנסות בתוכניות לימוד חדשות ויישום שיטות הוראה חדשניות ומגוונות, מהווים מודל עבור מורים עמיתים בתחילת דרכם בהוראה מחד גיסא, וגורם מניע ללמידת הכימיה עבור תלמידים רבים מאידך. סבלנותה הרבה, יחסה החם והרצון העז לתרום, לסייע ולקדם את עמיתיה ותלמידיה ראויים להערכה.

הפרס ניתן על:

- ♦ תרומה למקצוע הכימיה במישור הבית-ספרי ובמישור הארצי
- ♦ הוראת אוכלוסיות מגוונות של תלמידים - מצטיינים מחד ובעלי קשיי למידה מאידך
- ♦ קידום המעבדה ושילוב ניסויי יחידות מעבדה חדשניות
- ♦ ארגון ימים פתוחים הן לתלמידים והן להורים
- ♦ הפקת חומרי למידה מגוונים המתאימים לאוכלוסיית תלמידיה
- ♦ הנחיית מורים לכימיה חדשים וותיקים.

המסירות והאהבה לתלמידים ולמקצוע הכימיה התבטא במכתב שכתב אחד התלמידים ובו ציין כי דלית הינה "מורה לחיים".

ניתן לסכם ולאמור כי דלית מקבלת היום את פרס החברה הישראלית לכימיה כמורה מצטיינת לכימיה לשנת תשס"ד לאור ייחודיותה כמורה ותרומתה הרבה לקידום הוראת הכימיה בישראל.

הפרס הוענק במסגרת הכינוס השנתי ה- 70 של החברה הישראלית לכימיה.

### **באותו מעמד חולקו גם פרסים לתלמידי תיכון מצטיינים:**

**יוליה גוטה**, בי"ס "עיינות הירדן" בקיבוץ עמיר  
על עבודתה בנושא: הטמעת החנקן בצמח ברמות שונות של חומרים חנקניים זמינים ממצעי גידול אורגנים ואי אורגנים העבודה נעשתה בהדרכתו של המורה מיכאל קאופמן.

**שלומית עזרי**, בי"ס מקיף ז' ע"ש ניומן בבאר שבע  
על פעילותה והצטיינותה במיזם התעשייתי בהנחייתה של המורה דורית פלקוביץ.



# NEW CHEMISTRY OF THE NOBLE GAS ELEMENTS: NOVEL MOLECULES, POLYMERS AND CLUSTERS

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## I. Introduction

Since the discovery of the noble gases, well over a century ago, these elements have been a challenge to chemistry and to the understanding of chemical bonding. For many years after they were discovered, the chemical inertness of the noble gas elements was believed to be absolute. The advent of quantum chemistry in the 1930's and beyond led to first-principles understanding of the chemical inactivity. This was interpreted in terms of the remarkable stability of the closed-shell electronic structure of the noble gas atoms in the ground state. Pauling conjectured in 1933<sup>(1)</sup> that for the heavier noble gas atoms such as xenon, where the outermost electronic shell is less stable due to its relatively large distance from the nucleons, chemical bonding may be possible. The breakthrough came in 1962 when Bartlett prepared experimentally  $\text{Xe}^+[\text{PtF}_6]^-$ , xenon hexafluoro platinate, the first noble gas compound<sup>(2)(3)</sup>. This was followed by a period of steady growth, in which a good number of xenon compounds, and much fewer krypton and radon compounds were obtained<sup>(4-7)</sup>. There was also a significant development in the quantitative theoretical understanding of the chemical bonding of the heavier noble gases<sup>(8)</sup>. In the last several years, the field of noble gas chemistry has gone through a phase of rapid development in several different directions. A recent article by Christie<sup>(9)</sup>, highlighting some of the developments, is entitled "A Renaissance in Noble Gas Chemistry", which seems to reflect current impressions in the field. Some of these developments are described in several recent reviews<sup>(10-13)</sup>.

The results described in this paper are related to and motivated by the pioneering work done in recent years by Räsänen and coworkers in Helsinki<sup>(14-21)</sup>. These authors were able to obtain a range of molecules of the type  $\text{HNgY}$ , where Ng is a noble gas atom and Y an electronegative group, by photo dissociation of the hybrid HY in the noble gas Ng matrix<sup>(14-21)</sup>. Examples of molecules prepared in these experiments include  $\text{HXeH}$ ,  $\text{HXeOH}$ ,  $\text{HXeBr}$ ,  $\text{HKrCN}$  and  $\text{HArF}$ , the latter being the first chemically bound compound of argon<sup>(21)</sup>. The importance of these results is twofold: First, many new chemical bonds of the noble elements were discovered, including Xe-H, Xe-I, Xe-Br, Xe-S, Kr-H, Ar-H and Ar-F. Second, for the first time one of the light noble gas elements was harnessed into chemical bonding.

The results overviewed in the present paper include several contributions: (1) Theoretical simulations are used to yield understanding of the formation mechanisms of the  $\text{HNgY}$  compounds in the matrix. (2)  $\text{HHeF}$  is predicted to be stable in pressurized solid helium. This is a first chemically bound compound of helium. (3) A new family of organic noble gas compounds are found, the prototype of which is  $\text{HXeCCH}$ . These compounds, predicted by our calculations were already prepared experimentally. This is a rapidly growing area, and we discuss further extensions and possible future directions. (4) A first polymer made of xenon and carbon is predicted. The search for polymers opens exciting prospects in noble gas chemistry. (5) Stable aggregates and crystals of certain  $\text{HNgY}$  molecules are found to exist, suggesting an interesting new class of noble gas materials.

## II. Formation Mechanisms of $\text{HNgY}$ Noble Gas Compounds

### A. Direct formation dynamics

Potential energy surfaces developed by the author and coworkers<sup>(22)</sup>, combined with Molecular Dynamics simulations, indicate direct formation of  $\text{HNgY}$  products in an ultrafast process following photo dissociation of HY in the matrix, in a number of cases<sup>(13)(22)</sup>. In modeling the potential surfaces<sup>(22)</sup>, the Diatomics In Molecules (DIM) approach<sup>(23)</sup> was used to describe the interactions between the H and the Y atoms with the matrix atoms, but this treatment was augmented by the introduction of an additional interaction, representing the  $\text{HNgY}$  triatomic, obtained by fitting ab initio calculations for  $\text{HNgY}$ .<sup>(22)</sup> This

description of the electronic states is similar in part to the DIIS model of Last and George<sup>(24)</sup>. As it turns out, there is a whole manifold of excited states pertinent to the photochemical process, with crossings between some of the potential energy surfaces involved. Thus, nonadiabatic transitions between different electronic states must be incorporated in the dynamics, and this was done by the semiclassical Surface Hopping method<sup>(25),(26),(22)</sup>. The essential picture that emerges from this model is described qualitatively in Figures 1 and 2. Upon photoexcitation, the HY molecule is promoted to the repulsive manifold of states in the Franck-Condon region. As the H atom moves away from the Franck-Condon region, it ultimately

#### Photochemical synthesis of HKrCl

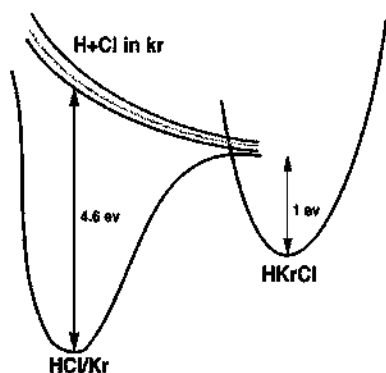


Fig 1. Potential energy curves for the HKrCl formation in solid Kr

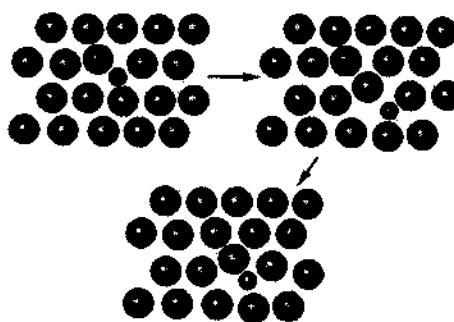


Fig 2. Snapshots showing the HKrCl formation in photodissociation of HCl in solid Kr

reaches a crossing with a state representing the bound molecule HNgY (Fig. 1). The molecule undergoes fast vibrational relaxation once HNgY is formed. As Fig. 1 shows, HNgY is much higher in energy than Ng+HY, but there is a barrier protecting the HNgY molecule which at cryogenic temperatures is practically insurmountable. Fig.2 shows snapshots from the formation dynamics. As the picture shows, the formation involves exit of the H atom from the cage<sup>(22)</sup>. Upon photolysis the H atom exits the original cage, recoils from the second layer of noble gas atoms, and hits an Ng atom which on the other side is adjacent to the Y atom (Cl in this case). The H·Ng·Y arrangement at this point corresponds essentially to the crossing in Fig. 1. HNgY is formed, and is stabilized by vibrational relaxation. We estimate that after a timescale of ~ 10 picoseconds the relaxation is already sufficient in most cases to prevent the back reaction to HY+Ng. Obviously, the formation yield is a key issue, and there is insufficient data as yet from the simulations on that. Moreover, this modeling was hitherto applied only to a couple of cases: HKrCl and HXeCl. There is evidence from the matrix experiments of Räsänen for such a direct mechanism in several cases (including HKrCl)<sup>(27)</sup>. Furthermore, HXeI was recently produced in gas phase (cluster) experiments<sup>(28)</sup>, which support the direct formation mechanism. However, ultrafast time-resolved experiments to demonstrate the picosecond timescale formation have not been carried out yet. Such an investigation of the formation is a very interesting challenge for photochemical reaction dynamics in matrices.

### B. Delayed formation by H diffusion

Experimental evidence shows that for most systems studied so far, the HNgY molecules are formed mainly by a delayed mechanism. This is the case, for example, for the formation of HArF following photolysis of HF in argon<sup>(21)</sup>, and in the formation of HXeOH in solid xenon<sup>(16)</sup>. In these experiments, there is no evidence for the presence of HNgY directly after the photo dissociation of HY in the matrix. Only upon a procedure of annealing, involving successive steps of heating and cooling, are the noble gas molecules found. Räsänen and coworkers have suggested that the formation involves H atom migration, induced thermally by the heating. Bihary et al.<sup>(29)</sup> were able to support this qualitative mechanism by simulations. This requires above all accurate potential energy surfaces for the motion of the H atom in the matrix, in sites at the proximity of a Y atom. Such potentials were obtained by fitting ab initio calculations. The relevant geometries and potential energy landscape are shown in Fig. 3. After photo dissociation

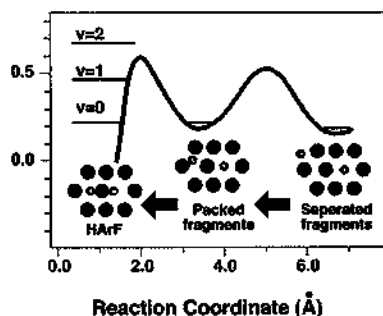


Fig 3. Potential energy landscape for the delayed formation of HArF

all atoms including the H are immobilized in their sites at low temperatures. Upon heating, thermally induced migration sets in. In the case of HArF, the most demanding barrier is the actual formation of the molecule by "hopping" of the H atom into the required geometry. Bihary, Chaban and Gerber<sup>(29)</sup> carried out Monte Carlo Transition State calculations, and were able to obtain threshold temperatures for the formation of HArF, HKrF in good accord with experiment.

It seems very important to pursue such calculations also for other systems, and to determine the relative yields of the direct and delayed mechanisms, which is a major open issue. There is no doubt that with better understanding of the formation mechanisms, yields can be increased and optimized, and pathways for formation of new molecules can be engineered.

### III. HHeF in Pressurized Solid Helium

With the first harnessing of argon into chemical bonding in the preparation of HArF, two elements are left in the periodic table for which no neutral, chemically bound molecule is known: helium and neon. It is obviously an exciting challenge to search for the possible existence of the helium and neon compounds. Wong found by ab initio calculations that HHeF, with a linear structure, corresponds to a local minimum on the potential energy surface<sup>(30)</sup>, and Lundell et al.<sup>(31)</sup> computed the unharmonic vibrational energy spectrum of these species. However, Chaban et al.<sup>(32)</sup> showed that HHeF, isolated in the gas phase, is not a stable molecule but a very short lived species, with a lifetime in the picosecond range. The difference between HArF (that is apparently of indefinitely long lifetime in the laboratory) and HHeF is that for the latter species the barriers against decomposition are much lower. Consequently, HHeF is predicted to decay by tunneling even in its lowest vibrational state. Bihary et al.<sup>(33)</sup> investigated the dynamical stability of HHeF in pressurized solid helium. They found that at pressures of 15 GPa or higher, which are experimentally feasible, HHeF is predicted to have an indefinitely long lifetime. The effect of the pressure is to practically eliminate the decay of the species by tunneling, and to leave it intact. At the same time, the calculations of Bihary et al.<sup>(32)</sup> show that also at the pressures mentioned the nature of the species itself is unaltered, and it is a chemically bound molecule, with vibrational frequencies very close to those of the gas phase species.

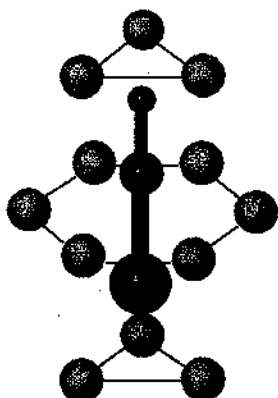


Fig 4. Local structure of HHeF in solid helium at pressure of 15 GPa

In summary, the theoretical results suggest two experimental approaches to the exploration of the species HHeF: (a) Using ultrafast femtosecond pulsed laser techniques, it may be possible to prepare the species and explore it as a transient of short lifetime. (b) It may be possible to prepare the species in pressurized solid helium (by photo dissociation of HF trapped in the solid). In these conditions, the species should have an indefinitely long lifetime.

#### IV. Organic HNgY Molecules: Noble Gas Atoms into Hydrocarbons

The author and coworkers have explored the existence of organic molecules of the type HNgY. The question of compounds made of noble gas atoms and hydrocarbons is particularly challenging, since such molecules, if found to exist, will not include any strongly electronegative atom. Approximately two years ago Lundell, Cohen and Gerber<sup>(34)</sup>, using ab initio calculations, predicted the existence of the noble gas/hydrocarbon compounds HXeCCH and HXeCCXeH, shown in Fig. 5. In the inorganic HNgY compounds, an approximate model of the bonding is that the species correspond to  $\text{H-Ng}^+\text{Y}^-$ , thus the  $\text{Ng}^+\cdots\text{Y}^-$  bond is dominantly ionic, while the  $\text{H-Ng}^+$  bond is essentially covalent. This picture applies

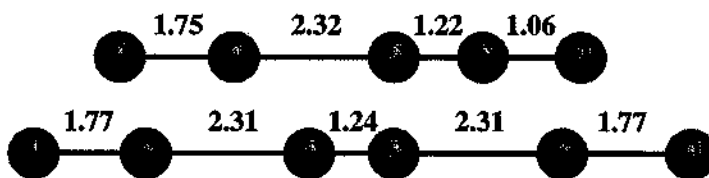
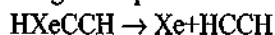
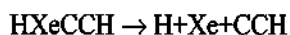


Fig 5. Equilibrium structures of HXeCCH and HXeCCXeH

also to HXeCCH (and HXeCCXeH): The bonding corresponds roughly to the model  $\text{H-Xe}^+-\text{CCH}$ , with a large fractional charge on the acetylenic group, while the H is covalently bound to the  $\text{Xe}^+$ . Indeed, the high electron affinity of the acetylenic group was the motivating factor for the authors of Ref. (34) in pursuing these compounds. The ab initio calculations predict that HXeCCH is in fact expected to be much more stable than most known inorganic HNgY compounds. The barrier for the decomposition channel:



has a height of 2.18 eV, and is very wide<sup>(34)</sup>. The decomposition channel



is highly endothermic (nearly 1.5 eV)<sup>(34)</sup>. This should suffice for kinetic stability well above the cryogenic

range of temperatures. The analogy with the electronic structure of inorganic HNgY suggests also a corresponding mode of preparation: Photolysis of acetylene in solid xenon. Shortly after our predictions were made, and with this motivation, two groups were able to prepare the noble gas/hydrocarbons. Räsänen et al.<sup>(35)</sup> made both HXeCCH and HXeCCXeH, while Feldman and coworkers<sup>(36)</sup> independently prepared HXeCCH. Shortly afterwards, Räsänen and coworkers have also prepared HKrCCH<sup>(37)</sup>. In the short period since these first preparations, the topic of noble gas/hydrocarbon compounds has developed rapidly, and several interesting new molecules were obtained. Some of the noble gas/hydrocarbon compounds originally predicted in Ref. (34), were not made yet. These include the insertion compound of xenon into benzene, HXeC<sub>6</sub>H<sub>5</sub>, which is indeed by the calculations less stable kinetically than the acetylene derivatives. In any case, the noble gas/hydrocarbon compounds seem to offer a very large number of options for future developments, and we expect that they may become a major sub-field of noble-gas chemistry.

## V. A Polymer Made of Xenon and Carbon

We extended the calculations on HXeCCH and HXeCCXeH, to explore the energetic stability of the species HXeCCXeCCXeH and HXeCCXeCCXeCCXeH. They were predicted to be stable by the ab initio calculations, with structures as shown in Fig. 6. This suggests the existence of a polymer with the repeat unit -(CCXe)-.

Since for the finite molecules the H-Xe bond makes a significant contribution to the stability, the

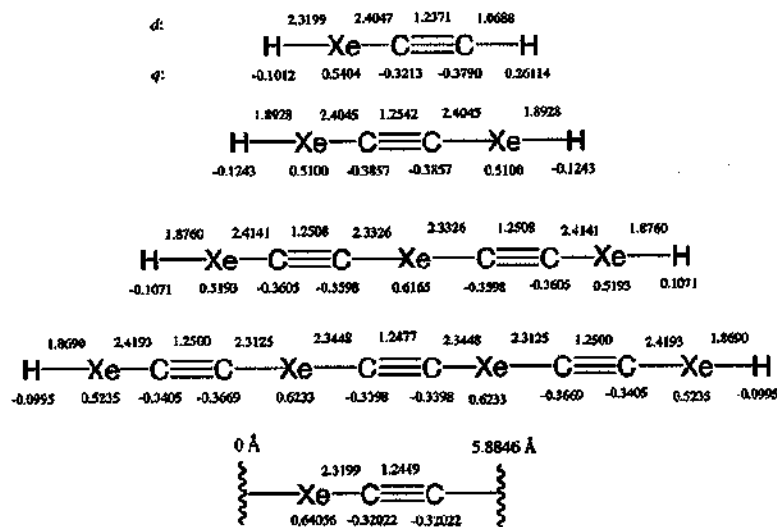


Fig 6. Computed structures for the HXe(CCXe)<sub>n</sub>H, and for the (Xe-CC)<sub>n</sub>

existence of the extended polymer was established by electronic structure calculations (DFT/B3LYP) using periodic boundary conditions<sup>(38)</sup>. The predicted polymer is a highly interesting and novel type of compound, no longer of the HNgY type. Indeed, it is unusual in many respects as a polymer. Our search for other noble gas polymers is continuing, and we believe there are some very interesting prospects. We note that the di-acetylenic bonding of xenon -CC-Xe-CC- is expected to be stable also in finite molecules. In recent ab initio calculations, the molecule HCCXeCCH was found to be very stable<sup>(38)</sup>. It seems that in

these di-acetylide compounds of the noble gases, the CC groups provide both covalent and ionic bonding contributions. We expect these molecules to have some potentially very useful properties as relatively very stable noble gas molecules, but these molecules are still to be prepared, and the main challenge on this is to develop suitable preparation strategies.

## VI. Organic and Silico Compounds of Argon

Obtaining new molecules of the lighter noble gases: Ar, Ne, He remains an outstanding challenge. Since HArF was prepared, no additional compound of argon was found experimentally. According to theory, however, there is ground for optimism. Fig. 7 shows a first organic molecule of argon and a first molecule with a silicon-argon bond, predicted in *ab initio* calculations<sup>(40)</sup>. No argon/hydrocarbon compound was predicted to be stable so far.

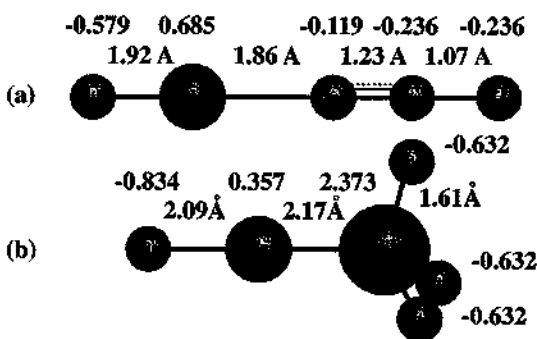


Fig 7. Structures of (a). FArCCH and of (b). FArSiF<sub>3</sub>

## VII. Crystals of HNgY Molecules

So far, the HNgY molecules were obtained as isolated species in rare gas matrices. Some complexes of these molecules with other molecules such as N<sub>2</sub> in the matrix are also known. However, can neat aggregates of HNgY, or even crystals or liquids be stable? Simulations show that this is not always the case. For example, the dimer (HArF)<sub>2</sub> was found to be chemically unstable, decomposing spontaneously into HF and argon<sup>(13)</sup>. Also on this issue, however, there is strong theoretical ground for optimism. Fig. 8 shows a predicted structure for the molecular crystal of HXeH<sup>(41)</sup>. Small clusters of this molecule were shown to be stable by *ab initio* calculations<sup>(42)</sup>.

It is not yet known if HXeH is expected to melt into a stable molecular liquid.

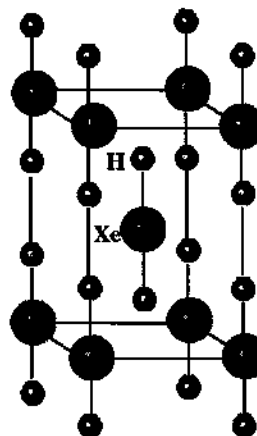


Fig 8. Proposed structural model for the molecular HXeH compound

## VIII. Concluding Remarks

Recent developments have greatly expanded the field of noble gas chemistry. Novel species of interesting types of bonding and unusual properties have been obtained. Theoretical predictions have made a contribution to these developments both in the interpretation of experimental findings, and in predicting new compounds and their properties and in suggesting mechanisms.

Above all, the extensive recent experimental and theoretical results seem to indicate an exciting future for the field in the next several years.

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### **Prof. Robert Benny Gerber**

was born in 1944. He received his B.Sc. in Chemistry (1965) from the Hebrew University of Jerusalem. He carried out his doctoral research in Theoretical Chemistry with Prof. C.A. Coulson at the University of Oxford, obtaining the D.Phil. in 1968. He was then a Postdoctoral Research Fellow with Prof. Martin Karplus at Harvard University. He joined the Weizmann Institute of Science in 1969, and from 1976 has been on the Faculty of Science at the Hebrew University of Jerusalem, where he holds the Saerree K. and Louis P. Fiedler Chair in Chemistry. From 1990, he also spends part of his time at the University of California at Irvine, where he is Professor of Chemistry.

Benny Gerber's research is in theoretical and computational chemistry, and his main current research interests include: (1) Molecular photochemistry in low-temperature matrices and clusters; (2) Prediction of new compounds of the noble gas elements, and their formation dynamics; (3) Vibrational spectroscopy methods for large molecules, and using spectroscopy for the development of new force fields for biological molecules; (4) Mechanisms and dynamics of molecular processes in atmospheric systems.

He has trained over 50 doctoral and postdoctoral researchers.

Prof. Benny Gerber is the recipient of the Israel Chemical Society Prize for 2004.



# PULSED LASER PATTERNING OF METALLIC THIN FILMS ASSISTED BY WEAKLY BOUND BUFFER LAYERS

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## 1. Introduction

The cost of manufacturing in VLSI procedures, the need for ever denser and narrower conducting wires together with the increasing concern of environmental penalties, have led to the search for new clean and fast lithographic processes. In addition to applications in the industry, basic issues such as thermal stability and diffusion of metallic particles on solid substrates, imprint for biological samples and bio-sensors, keep up the academic motivation and the general interest in the development of novel pathways for lithography and patterning at dimensions that approach the nanometer world.

Photo-lithography has been critical for VLSI in the semiconductor industry for decades. The concept of laser induced thermal desorption (LITD)<sup>1-4</sup> and ablation<sup>5</sup> are well known for the patterning of adsorbates on surfaces, and is widely used in surface diffusion studies<sup>1-5</sup>. It is applicable for relatively weakly bound adsorbates on surfaces. In contrast, the high laser power (above 20MW/cm<sup>2</sup>) typically needed for direct laser ablation of metallic films is often rather damaging for the substrate underneath. Consequently, such methods are rarely used for metallic layer patterning.

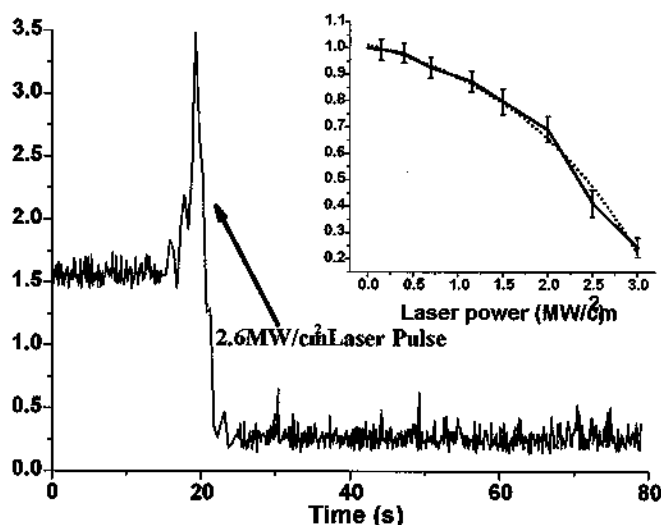
Physisorbed buffer layer has been introduced by Weaver and coworkers<sup>6-8</sup> as a way for a controlled deposition of metallic clusters on surfaces. The metallic nanocrystal average size and distribution can be controlled by adjusting the buffer layer thickness. It is therefore a proven method for the deposition of size selected clusters.

## 2. Laser desorption via buffer layer

The employment of a buffer layer can be adapted to overcome LITD limitations. Laser ablation of weakly bound layer like, e.g. Xe, requires relatively low pulsed laser power density, conserving the quality and smoothness of the underlying surface. The possibility to utilize laser ablation of a weakly bound buffer layer for the removal or patterning of metallic layer deposited on top can thus be explored.

In order to examine the basic concept, a monolayer of potassium was deposited on top of 20ML Xe on a metallic Ru(001) substrate, at 20°K in a UHV chamber. At a monolayer coverage, potassium strongly amplifies optical second harmonic (SH) response, at laser wavelength of 1064nm. It is therefore a perfect tool for in-situ detection of actual adsorbed quantity on the surface<sup>9</sup>. A laser pulse then strikes the entire sample surface, at a power of 2.6MW/cm<sup>2</sup> while continuously recording the total SH response of the K/Xe/Ru system, at the fundamental Nd:YAG laser wavelength. This is shown in Figure 1. Multilayer Xe desorbs from surfaces around 60K, however the desorption of potassium atoms directly in contact with the ruthenium surface occurs at temperatures above 350K<sup>4,9,10</sup>. The laser power used here is sufficient to ablate away the Xe from the Ru substrate. However it is incapable of inducing desorption of potassium adsorbed directly on the clean ruthenium substrate, where a minimum power of 10MW/cm<sup>2</sup> would be necessary. As shown in Figure 1, striking with a single laser pulse results in an immediate SH response cut-off, indicating that the potassium has been evaporated, together with the underlying buffer material. Residual potassium traces were then monitored by temperature programmed desorption, confirming that Xe ablation from the surface has indeed ejected the potassium deposited on top. The overall potassium coverage that could be evaporated this way depends exponentially on the absorbed laser power density, as shown in the insert of Figure 1.

The experiment depicted in Figure 1 is a clear evidence that pulsed laser patterning of metallic film is possible, if a weakly bound buffer material is involved, avoiding this way any damage to the substrate<sup>10</sup>.

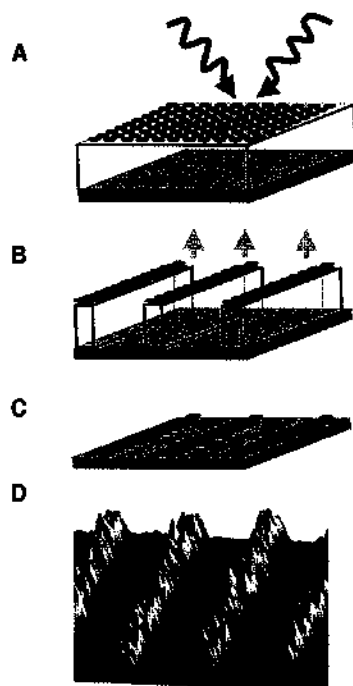


**Fig 1.** SHG intensity from 1ML potassium on Xe: before, during and after a single laser-desorption pulse. Potassium coverage after the pulse of 0.4ML was determined by calibrated optical second harmonic signal intensity and thermal desorption. Inset: potassium coverage remaining on the surface after a single laser pulse hits 1ML K on 60ML Xe, as a function of laser power density. The coverage was determined by the zero order SHG signal before and during SH-TPD. The dashed line represents an exponential fit.

As will be discussed below, two complementary procedures were developed for Buffer Layer Assisted Laser Patterning (BLALP). They are referred to as 'positive' and 'negative' laser lithography, in analogy to photolithography.

### 3. 'Positive' laser lithography via physisorbed buffer layer

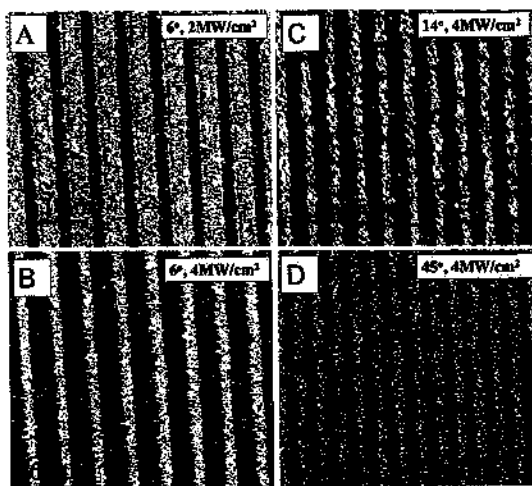
As a proof of concept, interference laser lithography of gold on top of a Ru(100) was performed via buffer layer of Xe and CO<sub>2</sub><sup>11</sup>. After a standard cleaning procedure in ultra high vacuum, the sample was



exposed to buffer gas, at 20K. Gold was then evaporated on top, at a rate of 1nm/min, as determined by in-situ quartz microbalance. This is schematically presented in Figure 2A. A single laser pulse is then split, recombines and interferes on the substrate, causing the desorption of the buffer layer and the ejection of the metal on top along the constructive interference troughs. This induces a one dimensional temperature modulation, and created a buffer-metal coverage grating, as depicted in Figure 2B. Finally, the sample was slowly heated (3K/s) to 100K. This step results in a slow desorption of the buffer layer and the soft landing of the remaining metal

**Fig 2.** A Schematic view of the buffer layer assisted laser patterning (BLALP) procedure: A) a metal film is deposited on top of a multilayer of buffer layer; B) spatial grating of the buffer material together with the metal film on top via LITD; C) removal of the buffer material by slow thermal annealing and "soft landing" of the remaining metal on the substrate; D) AFM image taken in air of a 40nm height 1.4 μm wide periodic gold clusters-strips on a Ru(100) substrate.

over the substrate. A metallic "wire" is then formed on the substrate, as shown in Figure 2C. Coverage grating formation is monitored in-situ in the vacuum chamber by optical diffraction methods. The sample structure is subsequently determined in air by AFM. AFM images, top view, are shown in Figure 3, for gold grating on Ru(100) created via the Xe buffer layer material.



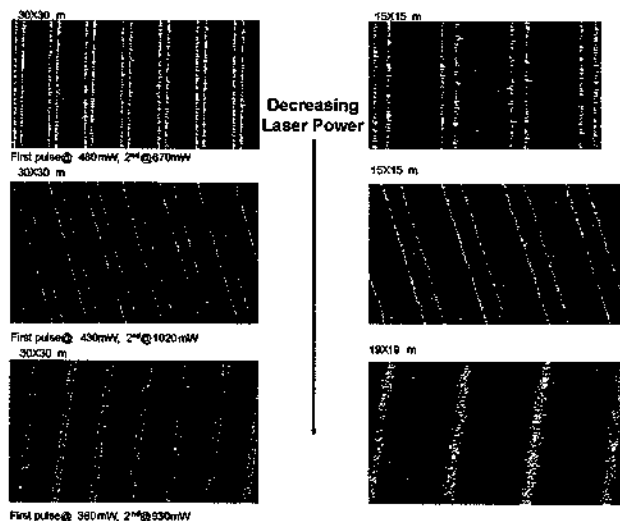
**Fig 3.** AFM images, measured ex-situ in air at room temperature of gold gratings on a Ru(100) substrate performed via "positive" BLALP. A) 30\*30  $\mu\text{m}$  image of 40nm height 2.8  $\mu\text{m}$  wide gold stripes (bright lines) within a period of 4.0  $\mu\text{m}$ , obtained at laser power density of 2MW/cm<sup>2</sup>; B) within same period, 40nm thick 1.4  $\mu\text{m}$  wide gold stripes (laser power of 4MW/cm<sup>2</sup>); C) 20\*20  $\mu\text{m}$  image of 2  $\mu\text{m}$  period, 700nm wide and 20nm thick gold stripes (laser power of 4MW/cm<sup>2</sup>, angle of 14° between interfering laser beams); D) 10\*10  $\mu\text{m}$  image of a 740nm period, 300nm wide and 10nm thick gold pattern (laser power of 4MW/cm<sup>2</sup>, angle of 45° between interfering laser beams).

The grating period ( $w$ ) depends on the angle of incidence ( $\phi$ ) between the two interfering laser beams, following Bragg law ( $w = \lambda / 2 \sin \phi$ ). In Figure 3A the period is of 4  $\mu\text{m}$ , generated with a laser wavelength  $\lambda = 1064\text{nm}$ , and angle of incidence  $\phi = 6^\circ$ . By increasing the angle to 45°, the period was reduced to 740nm with a grating line width of 300nm, as shown in Figure 3D. The width of the grating troughs is determined by the laser power. The desorption rate of adsorbed layers on surfaces depends exponentially on the substrates' temperature. Consequently an increase of laser power, thus temperature, in the spatial constructive interference troughs induces wider ablated stripes within the grating pattern, leaving behind narrower metallic lines on the surface (see Figures 3A and 3B).

The possibility to use other buffer materials than Xe has been demonstrated, using multilayer of CO<sub>2</sub><sup>11</sup> and H<sub>2</sub>O<sup>12</sup>. The role of higher heat capacity of the molecular buffers than Xe in determining the patterned layers profile is of great interest from the basic science point of view. The details of molecular desorption kinetic parameters is expected to influence the grating profile and its aspect ratio. Molecular buffer materials such as CO<sub>2</sub> and H<sub>2</sub>O desorb from surfaces at 100K and 160K, respectively, therefore require cooling the substrate at liquid nitrogen temperature rather than liquid helium, an important practical parameter.

#### 4. 'Negative' laser lithography

The negative BLALP has similar elements as in the "lift-off" procedure in standard photo-lithography. In this method, the buffer layer is laser patterned prior to the deposition of the metal film. A thin metallic layer is then deposited on top of the patterned buffer layer at the appropriate thickness. The ablated grating troughs then fill with a smooth layer of the vacuum-deposited metal, strongly attached to the substrate below. On the remaining buffer areas, however, the metal tends to coalesce into small 3D structures, as typical to growth on the buffer layer. A second, more intense, desorbing laser pulse is then applied,



**Fig 4.** AFM images of 5-8nm thick gold stripes formed via the negative BLALP procedure, for decreasing first laser pulse energy, as indicated. The second, ablating pulse energy varies as well in order to control the side clusters. Brighter stripes are the smooth gold.

striking the entire sample. This leads to ablation and therefore removal of the remaining buffer layer together with the metal deposited on top, in the same manner as described before. The patterned surface obtained this way consists of smooth metallic structures, in our case grating lines, on top of the substrate. In Figure 4, the effect of laser power in determining the width of deposited gold wires on top of Ru(001) via Xe as the buffer material is demonstrated. The negative BLALP procedure results in rows of large clusters along the stripes of smooth gold. These are apparently the result of the second laser ablation that leaves behind clusters that attach to the gold stripe on the surface. It is shown that the size of these clusters can be controlled to some extent by the second laser pulse power density. At low enough patterning laser energy (first pulse), narrow lines are formed where the clusters, otherwise along side the smooth gold stripes, coalesce to form a single narrow line.

## 5. Conclusions

Pulsed laser patterning via a physisorbed buffer layer opens new routes for lithography using fast and clean (all-in-vacuum) processes. The technique presented here is potentially an attractive alternative method for the deposition of periodic and more complex spatial patterns of conducting wires at widths well below the current limits. This may become a novel future technological pathway since it is a clean vacuum based procedure, thus faster and more efficient than wet photo-lithographical techniques that currently dominate in the microelectronics industry. It is predicted to enable the preparation of millimeters long, 50nm wide conducting wires using current laser technology, e.g. by application of shorter wavelength. The BLALP technique is essentially substrate and adsorbate independent, versatile and robust technique that can be employed with practically any element and chemical specie<sup>13</sup>.

## Acknowledgments

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### Prof. Micha Asscher

Born in 1949, in Kibutz Sede-Nechemiah, in the Chula Valley. Received his PhD in Physical Chemistry from the Hebrew University of Jerusalem under the supervision of Prof. Yehuda Haas. The Post-doctoral training was with Professor Gabor A. Somorjai in UC Berkeley, where he learned the basics of surface science.

In 1984 he joined the Institute of Chemistry at the Hebrew University of Jerusalem, as a faculty member in the Department of Physical Chemistry. In 1997 he was promoted to Professor. During 2001-2004 he served as Chairman of the Institute of Chemistry.

In his research he develops linear and non-linear optical methods to follow the kinetics and dynamics of chemical processes at the gas-surface interface under ultra high vacuum conditions as models for heterogeneous catalysis. Photochemistry of intact and caged molecules on oxide surfaces is studied as model for inter stellar photochemistry. Recently, a novel patterning technique at the sub-micron to nanometer dimensions has been developed in his group based on laser ablation of weakly bound buffer materials. As a result of this work he was chosen by Scientific American as one of 50 scientists who "exhibited outstanding technology leadership in the realms of research, business and policymaking" during 2003-2004.

# "LIVING POLYMERS" - 50 YEARS OF EVOLUTION

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## Introduction

The work on "Living Polymers" started at the College of Forestry, State University of New York, Syracuse NY, in 1955. The first publication was entitled: "Polymerization initiated by electron transfer to monomer. A new method of formation of Block Polymers", by M. Szwarc, M. Levy and R. Milkovich<sup>1</sup>.

In that one page communication, we showed that anionic polymerization can be carried out in the absence of a termination reaction. The term "Living Polymers" which was first introduced in that communication, is now widely used in the polymer literature and was officially recognized by the IUPAC Macromolecular Nomenclature Committee.

That work led to the following accomplishments:

**Monodisperesed polymers** were synthesized.

**Telechelic polymers** with active functional end groups were prepared by termination with proper reactants.

**Block copolymers** of the type ABA, AB or ABC were synthesized in a pure form, without any contamination of the respective homopolymers.

From the applied point of view, the monodispersed polymers (or rather polymers with very sharp molecular weight distribution) are commercially available today, as molecular weight standards for Gel Permeation Chromatography (GPC) calibration, and for a variety of investigations where polymers with well defined sizes are required. The telechelic polymers are used for preparation of block polymers, for binding polymers to surfaces or to microspheres and generally in building macromolecular structures. The block copolymers led to the discovery of thermoplastic elastomers of the type SBS (S-styrene, B-butadiene), and it was followed by a variety of polymers having chemically bound blocks with different properties, and resulting in new morphologies and applications.

Later on we introduced the term "Dormant Polymers"<sup>2</sup> in order to explain the lower polymerization rate found when the initiation was carried out by anthracene anion (instead of naphthalene anion used in the original work). It turned out that a reversible complex is formed between anthracene and the anionic living end, and therefore the propagation is slower, but it still maintains the characteristics of a living polymerization, because the equilibrium is very fast and therefore all the living ends have an equal opportunity to propagate.

Living polymerization has evolved in the last 50 years and conditions were discovered for various other types of anionic, cationic, ring-opening and free radical systems, in many laboratories around the world<sup>3-7</sup>. Protection of the living end from termination was done either by complexation or by steric hindrance and the right choice of reagents and solvents. The field has expanded tremendously and the term "controlled/living" polymerization is commonly used to cover all the methods.

There were many review articles written on living and controlled/living polymers. This is not another review article but an attempt to look at some of the interesting developments in the area in the last years.

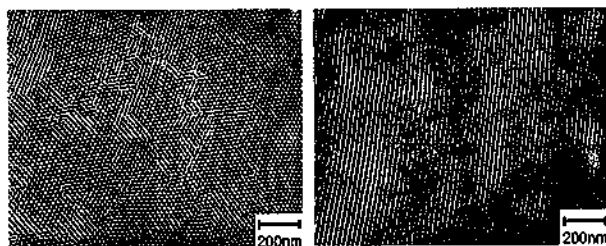
## Thermoplastic elastomers

The originally prepared ABA triblock polymers were of the BSB type. They did not show any unusual properties. However, a few years later, G. Holden and R. Milkovich<sup>8</sup>, working at the Shell Company, developed a new triblock polymer SBS, which turned out to be a thermally reversible elastomer. The polystyrene (PS) end blocks separated into distinct small discontinuous microphases that acted as cross-linking sites for the continuous polybutadiene (PB) phase. Unlike chemical crosslinking by sulfur, for

example, this rubber becomes fluid on heating above the melting point of PS and therefore it can be fabricated as a thermoplastic material, and upon cooling to ambient temperatures recovers its elastometric properties. This polymer was manufactured as a commercial product and sold under the trade name of Kraton. A variety of Kraton products are used as rubbers, as well as compatibilizing agents for polymer mixtures, as adhesives and even for odd applications such as improving the durability of asphalts.

Using a different processing method, solutions of SBS polymers rolled between two counter-rotating adjacent cylinders, while the solvent was allowed to evaporate, resulted in microphase separated globally oriented structures. The film produced consisted of polystyrene cylinders, assembled on a hexagonal lattice, in the PB matrix, in near single-crystal structure (Fig 1). The high ordered structures obtained may be viewed as nanoscale composites of a PB matrix reinforced with unidirectional PS rods. These structures lead to high degrees of mechanical anisotropy which is easily detected even by hand tugging on the films in different directions (Albalak<sup>9</sup>).

Using cationic living polymerization, well defined triblock soft barrier thermoplastic elastomers of the type PS-*b*-PIB-*b*-PS were synthesized (PIB – polyisobutylene, *b* - block). It is now a commercial product, under the trade name of TS-Polymer, manufactured by the Kurary Company (Kennedy<sup>4</sup>).



**Fig 1.** TEM micrograph of PS/PB/PS films roll-cast for 100min. (a) sectioned perpendicular to the oriented cylinders; (b) sectioned parallel to the oriented cylinders. The two projections exhibit PS cylinders assembled in a near single-crystal structure on a hexagonal lattice.

## Macromonomers and polymer brushes

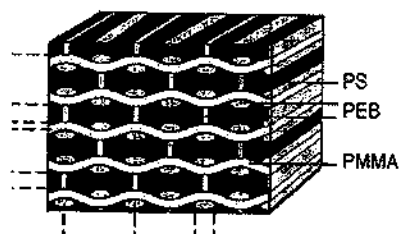
Macromonomers were prepared by terminating a living anionic styrene polymer with 4-chloro-dimethylsilyl styrene, by careful titration, until the red color of the living polymer disappeared. The product is in fact a styrene molecule with a PS (or a PS-*b*-PI) side chain. This monomer is then polymerized anionically using *sec*-BuLi. The whole procedure is carried out in the same reaction flask with all the components attached via breakseals in a vacuum system. The resulting molecule is poly-macro-styrene in a form of a perfect brush. Using this methodology, a new family of well defined complex macromolecular architectures can be synthesized (Pantazis<sup>10</sup>).

Polymer brushes were also prepared by self-assembly of a monolayer of 4'-bromo-4-mercaptobiphenyl on a gold surface, followed by reacting the Br with *sec*-BuLi and "grafting styrene from" the surface by living anionic polymerization. As an example, a PS brush, bound to the gold surface was synthesized, with a degree of polymerization (DP) of 380, a grafting density on the surface of 3.4 nm<sup>2</sup>/chain and the polymer monolayer was 18 nm thick. This is an important step in constructing well defined patterns on gold surfaces (Jordan<sup>11</sup>).

## "Knitting Pattern" morphology in a tri-block polymer

Block polymers give different morphologies depending on their structures and the method of casting. One unusual example is the following; the tri-block polymer PS-*b*-PB-*b*-PMMA, (PMMA – poly methyl methacrylate,) prepared by anionic living polymerization, gives a lamellar morphology on casting a film.

However, after partial hydrogenation of the PB block, it becomes PS-*b*-P(ethylene-co-butylene)-*b*-PMMA. This polymer gives an unusual knitting pattern morphology on casting from chloroform (Fig 2) (Breiner<sup>12</sup>).



**Fig 2a.** Schematic description of the knitting pattern morphology.

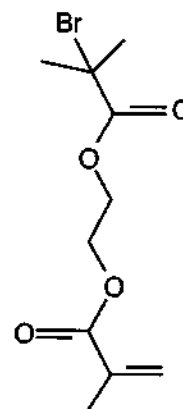


**Fig 2b.** Bright field transmission micrograph of S35 EB27 M38 stained with RuO4 (X5000)

### Nanoscopic structures

A combination of contact molding and living free radical polymerization was used for manipulating the size and chemistry of nanoscopic structures.

A standard patterning technique was used which involved casting a photopolymer resin on a hard silicon master. The resin contained 10-20% of an initiator-monomer (inimer) (Fig 3), which became part of the pattern and was evenly distributed throughout the cured resin, with a fraction advantageously located at or near the surface, being accessible for subsequent living graft polymerization. After addition of the co-catalyst CuBr and the monomer (S or MMA), atom transfer radical polymerization (ATRP) was carried out resulting in a surface grafted brush polymer with the required pattern and film thickness. The controlled thickness could be varied from 10 to 143 nm with grafts ranging in MWs from 18K to 290K. This allows controlling the size of the nanoscopic features down to 20 nm. This method is a combination of top-down and bottom-up strategies that gives researches new tools for reproducible fabrication of nanoscopic structures (Von Werne<sup>13</sup>).



**Fig 3.** Structure of the inimer

### Functionalization of carbon nanotubes:

#### 1. by Atom Transfer Radical Polymerization (ATRP)

A core-shell hybrid nanostructure composed of carbon nanotubes (CNT) and brushlike polystyrene was prepared by first attaching carboxylic groups to the CNT by nitric acid reaction, followed by treatment with sulfonyl chloride to attach a chloride. Further treatment with glycol introduced a hydroxyl group which was then treated with bromomethyl propionyl bromide which gave the attached initiator group. CuBr/PMDETA (pentamethyl diethylene triamine) and styrene (or other monomers) were then introduced and polymerized under controlled/living polymerization conditions. By later introducing a second monomer block polymers could also be attached to the CNT core. This paves the way for many applications of CNT in composites and structured nanomaterials (Kong<sup>14</sup>).



better results. Using thermal ring opening polymerization (ROP) can lead to a wide range of polyferrocenes with interesting properties. However, the best method was found to be polymerization of strained silicon bridged ferrocyclophanes (FS) using living anionic ROP with BuLi as initiator at ambient temperatures. The polymers obtained had low MWD. Block polymers with PS or polydimethyl siloxane (PDMS) were produced (Fig 5), as well as end functionalized polymers.

Self-assembly of ferrocene triblock copolymers PFS-*b*-PDMS-*b*-PFS gave flowerlike architecture with cylindrical micelles as a major component.

The structural diversity and immense range of properties of inorganic polymers may result in new supramolecular structures with novel applications (Manners<sup>18</sup>).

### New polyolefin architectures using Ziegler-Natta living polymerization

Olefin polymerization emerged in the early 1950's as a principal area of organometallic research when Ziegler and Natta discovered that titanium chloride in the presence of alkyl aluminum compounds was an efficient catalyst for ethylene and propylene polymerization. In 1979, the first Ziegler/Natta catalytic system to satisfy the requirements of living polymerization was reported. The catalyst was Vanadium (acetylacetonate)<sub>3</sub> activated with Et<sub>3</sub>AlCl. It produced partially syndiotactic polypropylene at -78°C with MWD 1.05-1.2. The MW increased linearly with time up to 100K.

It was reported lately, that amine biphenolate complexes of Ti (Fig 6), activated with B(C<sub>6</sub>F<sub>5</sub>)<sub>3</sub>, were very active initiators for the living polymerization of hexene, giving MWs of up to 450K, and MWD 1.07 at 65°C. Moreover, block polymers of hexene and octene were also obtained by consecutive addition of the monomers, at ambient temperature, with a MWD of 1.2 (Coates<sup>19</sup>).

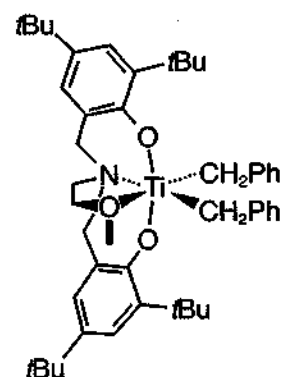


Fig 6. Amine bis(phenolate) precursor for living olefin polymerization

### Living photo-polymerization

Metalloporphyrins of various structures, and with a number of metals as central atoms, were shown to initiate anionic living polymerization of a number of monomers, including alkenes and epoxides. They also initiate alternating polymerization of epoxides and CO<sub>2</sub> or phthalic anhydrides, giving polycarbonates or polyesters with narrow MWD.

The surprising discovery was that some of the polymerizations can be performed only by irradiation with visible light, while others are accelerated considerably by light. For example: TPP-AlMe (tetraphenylprophinate aluminummethyl) does not polymerize MMA in methylene chloride, at 30°C. However, upon irradiation with visible light, 45% conversion to polymer is obtained in 12h with a MWD of 1.06-1.2, and a block copolymer of MMA and BMA is obtained with a MWD of 1.1. Furthermore, on addition of only 0.14% (relative to MMA) of a Lewis acid, such as a sterically crowded methyl aluminum dithiolate, complete conversion is obtained within 3 seconds, upon irradiation, giving a polymer with a MWD of 1.09. This is an acceleration factor of about 45000 (Aida<sup>20</sup>).

### Propagation of both ends of a polymer chain with two monomers by two different living/controlled methods – ROP and ATRP

$\epsilon$ -Caprolactone (CL) can be polymerized by ROP using lipase enzymes. MMA can be polymerized by ATRP. When a bifunctional initiator is used, both propagations can be carried out simultaneously from both ends of the chain as demonstrated in Fig 7. As can be seen, the two reactions can be carried out successively, by addition of the monomers one after the other, or simultaneously. The block polymers formed by the two methods are identical. The reactions were carried out in supercritical  $\text{CO}_2$ , which is an unusual and very interesting solvent, that has some advantages over conventional solvents, as it can be evaporated easily just by lowering the pressure, and it does not leave any impurities.

The following is an example of a block polymer formed by this method: using supercritical  $\text{CO}_2$  at  $35^\circ\text{C}$ , and 10 MPa. MMA was polymerized by ATRP, using  $\text{CuBr}$  and bipyridine as catalysts. CL was polymerized simultaneously by ROP using immobilized lipase enzyme (Novozym – 43J). The block polymer formed had a  $M_n$  of 23K and MWD of 1.26. After hydrolysis of the CL block the remaining PMMA had a  $M_w$  of 5.4K and MWD of 1.08. An unusual phenomenon worth mentioning is that the CL acted as a monomer as well as a cosolvent and a plasticizer and prevented the precipitation of the PMMA. This is another demonstration that the field of living/controlled polymerization is still showing new and surprising developments leading to materials and structures that could not be realized before (Duxbury<sup>21</sup>).

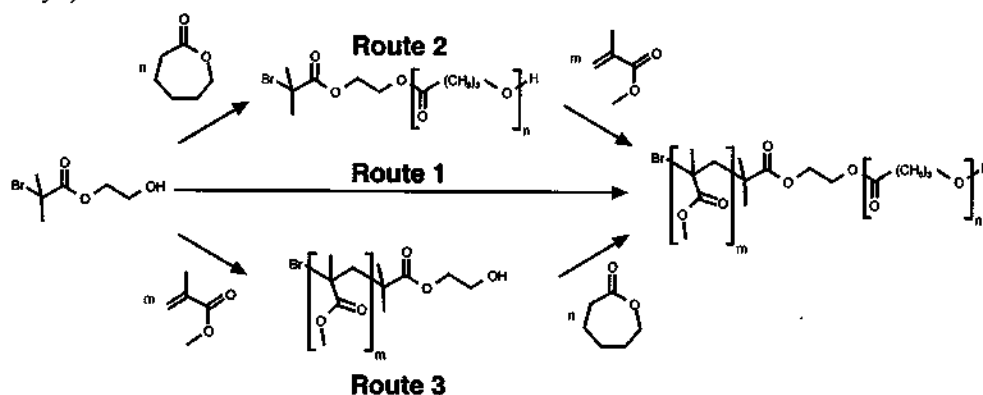


Fig 7. Synthetic routes to form PCL-*b*-PMMA from a bifunctional initiator. Route 1. simultaneous, single-step polymerization combining ATRP of MMA and ROP of  $\epsilon$ -CL. Two-step routes: Route 2, the ROP of  $\epsilon$ -CL followed by the ATRP of MMA. Route 3, the ATRP of MMA followed by the ROP of  $\epsilon$ -CL.

### Block Copolypeptides

Natural proteins are polypeptide copolymers which have an exact sequence of amino acids in their chain and therefore a MWD of 1.00. They are produced by ribosomes, which are the universal cellular organelles catalyzing the sequential polymerization of amino acids according to the genetic blue print, encoded in the mRNA. It is an extremely complex system with an amazing ability to synthesize precisely controlled sequence and composition of the amino acid monomers<sup>22</sup>.

There has been considerable interest in developing synthetic routes for the preparation of natural proteins,

## 2. by anionic polymerization of CNT-bound p-methylstyrene.

The previous method involved treating the CNTs with nitric acid and thus reducing the size of the tubes and introducing structural defects. The following method involves only a minor chemical modification by ligand-exchange with ferrocene which does not alter the overall graphene structure of the CNT. This is then followed by lithiation of the bound ferrocene with butyl lithium and termination with p-chlorostyrene. The double bond of the bound styrene is then reacted with a living anionic polystyrene of predetermined MW. The resulting modified CNTs can then be dispersed in a number of common solvents and show distinct colors (Fig 4) (Liu<sup>15</sup>).

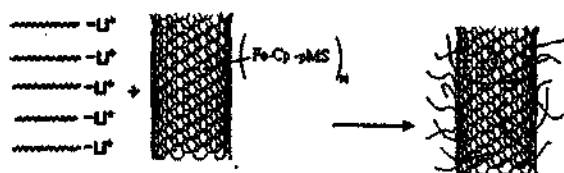


Fig 4. Polymer grafted on CNT

## Diblock copolymer nanofibers

The property of block polymers to self assemble into well defined structures can be used to form stable nanofibers. Block polymers with a photo-crosslinkable monomer can be prepared, cast into a film to give a cylinder core which is then crosslinked into a stable configuration.

For example, a block polymer of PS-*b*-PCMA (poly cinnamoyl ethyl methacrylate) was prepared by anionic polymerization. After casting into a film, ordered domains were formed, where the inner cylindrical core was the PCMA and the PS was the outer shell. The inner core was then crosslinked photochemically and processed in THF to yield stable and highly uniform nanofibers, 25 nm thick and thousands of nanometers long. Using the same method nanowires can also be formed when the core block is replaced with a conductive polymer. The outer layer will then act as an insulating plastic layer (Liu<sup>16</sup>).

## Monodispersed dendronized polymers with extremely high MW

Monodispersed poly (p-hydroxystyrene) (commercially available, prepared by living anionic polymerization) was used for preparing monodispersed dendritic molecules. The OH of the p-hydroxystyrene was reacted with the benzylidene protected (isopropylidene-2,2-bis(oxymethyl) propionic anhydride to yield the polyester. The protecting group was quantitatively hydrolyzed by acid, resulting in two OH groups for each single one in the polymer chain. This procedure was repeated five times resulting in 32 OH groups for each original one. The result was a very high molecular weight dendronic molecule.

As an example: starting with a polymer with a MW of 153K and a Molecular Weight Distribution (MWD) of 1.05, after 5 reactions steps the calculated MW was 4760K and the measured MW was 4630K, with a MWD 1.04.

It should be noted that when the MW of the dendronic polymer was measured by Size Exclusion Chromatography (SEC) it gave a value of only 666K with a MWD of 1.3. The reason is that the dendron does not assume a random coil configuration in solution because it is a very crowded molecule and it is closer to a rigid rod. Therefore, when the MW measurements were carried out by SEC combined

with Multi-Angle-Laser-Light-Scattering (MALLS) as the analysis method, it gave the correct value of 4630K.

Indeed, Scanning Force Microscopy (SFM) images of the dendrons show mainly single stretched molecules.

It was also shown that the polymer exhibited thermo-reversible physical gelation which is typical for rigid rodlike polymers. Unlike regular gelation, which is due to hydrogen bonding, donor-acceptor interactions, or other functions that result in the formation of a three-dimensional network, in this case it is due to the stiffness of backbone. The best gelation was demonstrated on a polymer containing 8 OH groups, for each original one, and esterified with stearyl groups (Yoshida<sup>17</sup>).

### Functional supramolecular inorganic polymeric materials

Inorganic polymers offer the potential of adding new dimensions to the common organic polymers that are based mainly on carbon chemistry. Thus, polysiloxanes with Si-O skeleton, or polyphosphazenes with the P-N skeleton and polysilanes with the Si-Si chain are stronger, more oxidatively stable and more conformationally flexible than the C-C based polymers. The introduction of metallic elements offers the possibility of ready access to stable structures that possess unpaired electrons. Such polymers can exhibit liquid crystallinity, or electronic, magnetic, optical, redox and catalytic properties. Moreover they can also be the precursors to ceramic materials with well defined structures when modified by photolysis or thermolysis. They can also be the basis to some supramolecular structures with remarkable properties ranging from high-temperature superconductivity, nonlinear optical behavior, magnetic and electrochromic properties.

The common methods for producing inorganic polymers lead to materials with relatively low MWs and high polydispersity. It was found that controlled/living polymerization methods can be used for obtaining

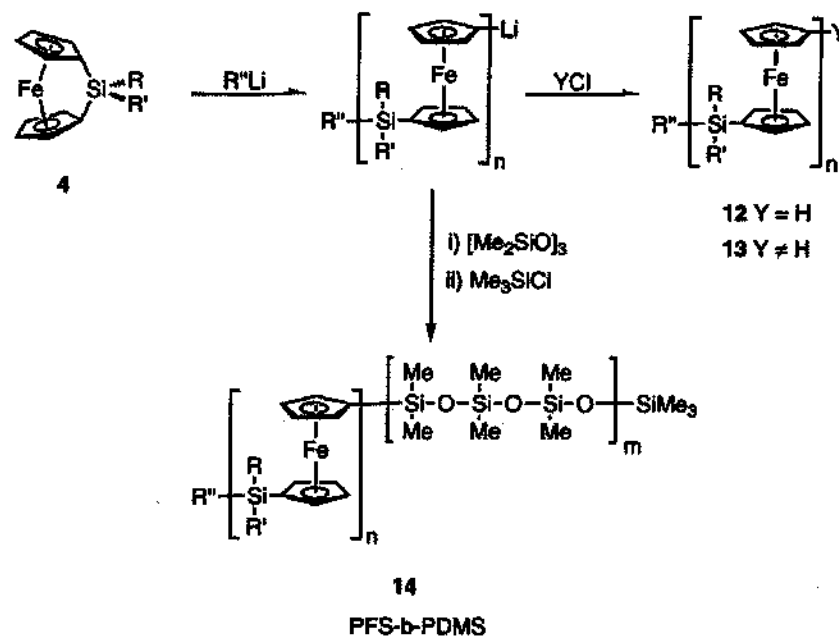


Fig 5. Block copolymer of poly ferrocyclophane and poly dimethyl siloxane.

as well as other polypeptide polymers. Besides their role in biological systems polypeptide polymers have the advantage, over most synthetic polymers, of being able to self-assemble into secondary structures in solution, due to cooperative hydrogen bonding, hydrophobic, electrostatic and dipolar interactions that result in three-dimensional structures. The major direction in polypeptide synthesis is by polymerization of  $\alpha$ -amino acid-N-carboxy anhydrides (NCA), using different nucleophiles and bases. This method has some major disadvantages.

It was recently discovered by Deming<sup>23</sup> that some Cobalt and Nickel complexes polymerize NCAs, in a living type polymerization, to yield polypeptides with very narrow molecular weight distributions, and very high conversions. Moreover, upon addition of a different NCA, a block copolypeptide is formed with well defined sequence and composition. The area of synthesis of well defined polypeptide block polymers by living polymerization techniques may result in new polymers with interesting three dimensional structures and new applications.

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### **Prof. Moshe Levy**

Born in Saloniqua, Greece, in 1927; immigrated to Israel in 1933.

Received his M.Sc. in chemistry from the Hebrew University, Jerusalem, in 1952 and his Ph.D. from the State University of New York, Syracuse NY, in 1955. Served as a Lecturer, in the Physical Chemistry Department, Technion, Haifa, during 1957 to 1960. Since 1962 he is at the Chemistry Faculty of the Weizmann Institute of

Science, Rehovot, and from 1977 to 1983 he was the Head of the Plastics Research Department. He spent Sabbatical leaves and visiting professorships in Rutgers University, the State University of New York, Xerox Research Labs, Casali Institute, DuPont Central Research, the University of Florida, and the University of Minnesota. He is a Professor Emeritus since 1993. He was the President of the Israel Polymer and Plastics Society during 1993 to 1995, and is presently the Editor of *Chemistry in Israel*. His areas of research include: Polymer Science, Biomedical Research, Kinetics and Chemical Processes, Catalysis, Oil Shales and Solar Energy.

## The 70<sup>th</sup> Meeting הכינוס ה-70

Was held on February 15 and 16, 2005  
At the David Intercontinental Hotel in Tel-Aviv

Under the auspices of the  
Chemistry Department of Bar-Ilan University.

**Organizing Committee:** Amnon Albeck, Chairman, Doron Aurbach, Bilha Fischer, Shmaryahu Hoz, Mordechai Livneh, Shlomo Margel, Avraham Nudelman, Richard Shultz.

The meeting was opened by Prof. Amnon Albeck, who then invited Prof. Shammai Speiser, the President of the Society, to address the meeting. Prof. Speiser noted that it was the 70th Annual Meeting of the Society and he welcomed all the past Presidents who were in attendance. He presented Prof. Shalom Sarel, the first President of the Society, in its present status, with a special Certificate of appreciation for his contributions to chemistry in the country.



The photograph on the right, was taken at the Annual Meeting of the Society in 1963. It was the first time that a scientific meeting was held in the city of Beer-Sheva. It shows Prof. Sarel, the President of the Society at the time, handing an Honorary Membership of the Israel Chemical Society to David Ben-Gurion, the first Prime Minister of the State of Israel. (Seated, B.G. and Felix Bergmann, standing, Shalom Sarel and Ernest David Bergmann). (see also front cover).

The scientific program included 7 Plenary Lectures, 1 Keynote Lecture in the Chemical Education Session, and 64 Invited Lectures in 16 Sessions.

192 Posters were also presented.

The ICS Medal and the ICS Special Awards were presented at a special Dinner Ceremony.

For detail about the awards see next chapter.

## SCIENTIFIC PROGRAM

### Plenary Lectures

Oxy-Radicals, Membranes and the Life-Death Nexus

A.A. Frimer (Bar-Ilan University)

Functional Polymer Templates for the Control of the Chemical Nanostructures

M. Antonietti (Max-Planck-Institute of Colloids and Interfaces, Germany)

### **ICS Award Lecture**

New Chemistry of the Noble Gas Elements: Novel Molecules, Polymers and Crystals  
**R.B. Gerber** (The Hebrew University of Jerusalem)

### **ICS Award Lecture**

Elemental Fluorine in Organic Chemistry: From the Backstage to Central Stage  
**S. Rozen** (Tel-Aviv University)

An Integrated Systems-Oriented Approach to Molecular Electronics  
**J.F. Stoddart** (UCLA)

Novel Biocatalysts: Challenges and Prospects  
**E. Keinan** (Technion-Israel Institute of Technology)

Synthesis as a Physical Organic Tool  
**J.S. Siegel** (University of Zurich)

### **Parallel Scientific Sessions**

#### **S1 - Structural Biology**

Solving 3D Structures of Eukaryotic Protein Complexes at the Israel Structural Proteomics Center (ISPC)  
**S. Albeck** (The Weizmann Institute of Science)

Allostery and Break in Symmetry in Chaperonins  
**A. Horovitz** (The Weizmann Institute of Science)

Crystal Structure of Yeast V-ATPase Subunit C Reveals its Stator Function  
**N. Nelson** (Tel-Aviv University)

Conserved Gating Hinge Mechanics in Ligand- and Voltage-Dependent K<sup>+</sup> Channels  
**O. Yifrach** (Ben-Gurion University of the Negev)

#### **S2 - Inorganic Chemistry**

Dispersions of Catalytic Phases in Mesostuctured Matrices and their Nanocasts as High-Performance Catalytic Materials  
**M.V. Landau** (Ben-Gurion University of the Negev)

Hydrogen bonding of atmospheric interest: H<sub>2</sub>SO<sub>4</sub>...H<sub>2</sub>O and (CH<sub>3</sub>)<sub>2</sub>SO<sub>2</sub>...H<sub>2</sub>O Interactions  
**A. Loewenschuss** (The Hebrew University of Jerusalem)

The Mechanical Properties of Individual WS<sub>2</sub> Nanotubes  
**R. Tenne** (The Weizmann Institute of Science)

Reactions of Alkyl Radicals with Metal Powders and Colloids Immersed in Aqueous Solutions  
**D. Meyerstein** (Ben-Gurion University of the Negev)



### **S3 - Polymer Chemistry**

Nano Acrylate: Smart Tailor-Made Carrier

**Y. Bareket** (B.G. Polymers)

Enantioselective Crystallization of Some Amino Acids with Chiral Polymers

**Y. Mastai** (Bar-Ilan University)

Self-Aggregation in Block-Copolymer Solutions

**Y. Talmon** (Technion-Israel Institute of Technology)

L-Lactide Polymerization Using Single-Site Bimetallic Calixarene Catalysts

**A. Vigalok** (Tel-Aviv University)

### **S4 - Organic Chemistry**

Bifunctional Aminoglycosides: Antibacterial Activity Against *Bacillus Anthracis* and Inhibition of Anthrax Lethal Factor

**M. Fridman** (Technion-Israel Institute of Technology)

Synthesis of Functionalized Eight Membered Carbocyclic and Fused Bicyclic Systems from Cyclohexanone via Alkoxy Radical Fragmentation (ARF) Reaction

**A. Hassner** (Bar-Ilan University)

Intramolecular Cross-links in Dendrimers: Creation of Rigid Organic Nanoparticles and Insights on the Process

**N.G. Lemcoff** (Ben-Gurion University of the Negev)

Step-by-Step Solid-Phase Synthesis of Well Defined Polymer-Supported Catalysts

**M. Portnoy** (Tel-Aviv University)

### **S5 - Industrial Chemistry**

Compounds for Vascular Targeted Photodynamic Therapy

**D. Eren** (Steba Laboratories)

Kinetic Research as a Tool for Process Modeling and Optimization

**M. Grabarnick** (Makhteshim Chemical Work Ltd.)

Ionic Liquids: Design, Preparation and Application to "Green" Chemistry

**N. Greenspoon** (Chemada Fine Chemicals)

Integrated Approach to the Development of Flowsheets

**B. Grinbaum** (TAMI)

### **S6 Organometallic Chemistry**

The Design of the New Universal Catalyst for the Sonogashira-Type Coupling of Aryl Chlorides

**D. Gelman** (The Hebrew University of Jerusalem)

Oxygen and Nitrogen Atom Transfer from Isolated Oxo and Nitrido Complexes

**Z. Gross** (Technion-Israel Institute of Technology)

Group IV Complexes of Amine-Phenolate Ligands as Catalysts for Polymerization and for Asymmetric Transformations

**M. Kol** (Tel-Aviv University)

Everything You Always Wanted to Know about Metallabenzenes but were Afraid to Ask  
**J.M.L. Martin** (The Weizmann Institute of Science)

## **S7 Materials Science**

Organically Doped Metals: A New Family of Materials

**D. Avnir** (The Hebrew University of Jerusalem)

Nanorods and Nanowires: One-Dimensional Chemistry and Spectroscopy

**S. Efrima** (Ben-Gurion University of the Negev)

Nanostructures Made of Nanoparticle Building Blocks

**I. Rubinstein** (The Weizmann Institute of Science)

Magnetic Nanoparticles and Their Applications

**A. Ulman** (Bar-Ilan University)

## **S8 Medicinal Chemistry**

Biopolymers for the Stabilization and Delivery of Peptide and Protein Drugs

**A.J. Domb** (The Hebrew University of Jerusalem)

How Does the P2Y<sub>1</sub>-(ATP)-Receptor Discriminate between Diastereoisomeric Drugs?

**B. Fischer** (Bar-Ilan University)

Chemical Chaperones that Target Protein-Protein Interaction Sites: Application for Anti-Cancer Lead Compounds

**A. Friedler** (The Hebrew University of Jerusalem)

Structure Based GPCR Drug Discovery: From Computer to Clinic

**Y. Marantz** (Predix Pharmaceuticals)

## **S9 - Membrane Biochemistry**

Efficacious Nucleic Acid Delivery in Vitro and in Vivo: Chemical, Biochemical, and Biophysical Aspects

**Y. Barenholz** (The Hebrew University of Jerusalem)

Biophysical Properties of Membranes Affect the Uptake, Topography and Photochemical Efficiency of Photosensitizers

**B. Ehrenberg** (Bar-Ilan University)

Chromatic Thin Lipid/Polymer Films for Studying Membrane Interactions

**R. Jelinek** (Ben-Gurion University of the Negev)

A New Family of Antifungal Compounds Composed of Fatty-Acid-Conjugated Cationic Peptides

**Y. Shai** (The Weizmann Institute of Science)

### **S10 - Electrochemistry**

Silicon Negative Potential Dissolution (NPD)-From Polishing to Texturing and Related Mechanism  
**Y. Ein-Eli** (Technion-Israel Institute of Technology)

Electrodeposition of Semiconductor Films  
**G. Hodes** (The Weizmann Institute of Science)

Direct Oxidation Fuel Cells (DOFC) Status and Potential Applications  
**E. Peled** (Tel-Aviv University)

Extending the Current Collector into the Nanoporous Electrodes of Photoelectrochemical Systems  
**A. Zaban** (Bar-Ilan University)

### **S11 - Single-Particle Spectroscopy**

Exact Solution for the Influence of Spectral Diffusion on Single Molecule Photon Statistics  
**E. Barkai** (Bar-Ilan University)

Single-Molecule Studies of Protein Folding and Association  
**G. Haran** (The Weizmann Institute of Science)

Monomer Dynamics in DNA and Actin Polymers  
**O. Krichevsky** (Ben-Gurion University of the Negev)

Polarized Raman Scattering from Single GaN Nanowires  
**T. Livneh** (KAMAG)

### **S12 - Physical-Organic Chemistry**

Novel Types of Persistent Silyl Radicals  
**Y. Apeloig** (Technion-Israel Institute of Technology)

Reactivity of Pentacoordinate Siliconium-Ion Complex Salts  
**D. Kost** (Ben-Gurion University of the Negev)

Mechanistic Studies of GTP Hydrolysis by G-Proteins  
**A. Shurki** (The Hebrew University of Jerusalem)

Nanodisks from Bis-benzymes. A DFT Study Aimed Towards Experimental Systems  
**A. Stanger** (Technion-Israel Institute of Technology)

### **S13 - Protein Biochemistry**

The MntC Crystal Structure Suggests that Import of  $Mn^{2+}$  in Cyanobacteria is Redox Controlled  
**N. Adir** (Technion-Israel Institute of Technology)

Overcoming DNA Replication Blocks: Survival at the Price of Mutation  
**Z. Livneh** (The Weizmann Institute of Science)

Mimitopes of the Acetylcholine Receptor Binding Site: from Synthetic Peptides to NMR Solution Structure  
**T. Scherf** (The Weizmann Institute of Science)

In Silico Predictions of ADME Related Properties  
**H. Senderowitz** (Predix Pharmaceuticals)

## **S14 - Electrochemistry and Analytical Chemistry**

Electrochemical Oxidation of Siloles

**J.Y. Becker** (Ben-Gurion University of the Negev)

Developments in Electroanalytical Chemistry

**E. Kirowa-Eisner** (Tel-Aviv University)

Speciation of Inorganic Polysulfides

**O. Lev** (The Hebrew University of Jerusalem)

How Can Sol-Gel Chemistry be Utilized in Electroanalytical Applications?

**D. Mandler** (The Hebrew University of Jerusalem)

## **S15 - Physical Chemistry**

Young Chemist Award Lecture

Principles and Progress in Single-Scan Multidimensional NMR

**L. Frydman** (The Weizmann Institute of Science)

Synthesis, Structural and Magneto-Optical Characterization of PbSe/PbS and PbSe/PbSe<sub>x</sub>S<sub>1-x</sub> core-shell Nanocrystals

**E. Lifshitz** (Technion-Israel Institute of Technology)

Protein Dynamics from NMR: Improved Stochastic Models

**E. Meirovitch** (Bar-Ilan University)

Molecular Electronics: the Effect of Local Environment on Conduction

**Y. Selzer** (Tel-Aviv University)

## **S16 - Lecture Demonstrations in Chemical Education**

Chemical Education Awards

Burning Hydrogen in Chlorine and in Bromine Gas - a Demonstration

**Y. Sivan** (Menahem Begin High School, Safed)

Lecture Demonstrations as a Context for Classroom Discussion

**G. Ashkenazi** (The Hebrew University of Jerusalem)

Thermochromism, Electrochromism, Photochromism: Materials Science Experiments

**M. Najdoski** (Cyril and Methodius University, Republic of Macedonia)

Smoking Cigarettes and Water-pipes from a Scientific-Chemical Point of View

**R. Blonder** (The Belmonte Science Center for Youth, The Hebrew University of Jerusalem)

**Kyenote Speaker**

Microscale Experiments Dealing with the History of Making Fire. From Fire Drills to Jet Flame Lighters

**V. Obendrauf** (University of Graz, Austria)

## **The Israel Chemical Society Medal for the year 2004 is awarded to**

### **Prof. Ruben Pauncz**



The Israel Chemical Society is hereby awarding the ICS Medal to Professor Ruben Pauncz in recognition of his unique pioneering and continuing contributions to the development and establishment of theoretical chemistry in Israel and world wide.

Following immigration to Israel in 1956, he was the first to introduce teaching of the fundamentals of quantum chemistry for undergraduate students at the Technion and taught for years the graduate course in quantum chemistry at the Weizmann Institute. Some of his doctoral students have become leading faculty members in Israel and abroad.

Professor Pauncz was the principal lecturer at the quantum chemistry summer school in Uppsala and in the Winter School in Florida. He is one of the founders of the International Academy for Molecular Sciences, whose members are some of the leading scientists in the world.

In addition to his many scientific papers, Professor Pauncz has published 5 important books, the last one when he was 80 years old, while still teaching a graduate course at the Technion.

## **The Israel Chemical Society Prize for the year 2004 is awarded to**

### **Prof. Benni Gerber**



The Israel Chemical Society awards its annual distinguished chemist prize for the year 2004 to **Prof. Benni Gerber** of the Hebrew University for his pioneering research in the theories of molecular dynamics and in particular for developing numerical methods for obtaining the energetic spectra of large molecules.

Prof. Gerber invented the Vibrational Consistent Field method and its refinements which include correlations between vibrational modes. The methods developed by Prof. Gerber for calculating spectra of complex molecules have been adopted by many groups and are especially used for highly excited states, far from the "harmonic limit".

Prof. Gerber has many contributions in other fields of molecular dynamics, amongst them, the derivation of interaction potentials between atoms and molecules from scattering experiments and the investigation of the photochemistry of molecules in cold matrices.

Benni Gerber was born in the U.S.S.R. in 1944, and immigrated to Israel in 1949. He received his B.Sc. degree in Chemistry from the Hebrew University in 1965. His doctoral studies were done with Prof. C.A. Coulson at the Oxford University. In 1968 Gerber went to his Post-doctoral studies with Prof. M. Karplus at Harvard University. Prof. Gerber returned to the Weizmann Institute and in 1976 moved to the Hebrew University. Since 1990 he holds dual professorship positions at the Hebrew University and the University of California at Irvine. He has guided many graduate and post-doctoral students in both places.

**The Israel Chemical Society Prize for the year 2004 is awarded to  
Prof. Shlomo Rozen**



Prof. Shlomo Rozen is awarded the 2004 Prize of the Israel Chemical Society for his creative and seminal contributions in the field of organic and fluoro-organic chemistry. Fluorocarbon materials are of great importance both in pure and applied sciences. Numerous fluoro-polymers such as various Teflons, hydrogen fluorocarbon (HFC's) compounds with zero ozone depletion potential, many fluorine containing drugs and agriculture agents, materials possessing the radioactive  $^{18}\text{F}$  isotope for use with positron emitting tomography - PET and emulsions of perfluorinated materials acting as artificial blood, are only a few examples of their importance in our daily life. Yet, the number of synthetic methodologies for preparing these materials was limited. For many years it was assumed that the most reactive element of the periodic table  $\text{F}_2$ , cannot be used as a convenient reagent for the synthesis of fluorocarbons. The group of Prof. Rozen has shown the reverse by designing several handy synthetic routes for the fluorination of non-activated C-H bonds of organic compounds. Furthermore, molecular fluorine could also be used for generating several important secondary reagents such as acetyl hypofluorite and methyl hypofluorite, the latter being the smallest organic molecule which was unknown till its recent synthesis and which is a source for the unique methoxilium species. Of special interest is the preparation of the acetonitrile complex of the hypofluorous acid -  $\text{HOF}/\text{CH}_3\text{CN}$  considered today to be the best oxygen transfer agent chemistry has to offer.

Shlomo Rozen was born in Bulgaria, and immigrated to Israel in 1951. He did his M.Sc and Ph.D studies at the Hebrew University in Jerusalem with Professors E. D. Bergmann and I. Shahak, and his post doctoral studies with the Noble Laureate Prof. D. H. R. Barton. He joined the School of Chemistry of the Tel Aviv University in 1976 and was appointed as a Full Professor in 1989. He served as the head of the School of Chemistry in the years of 1997-2001 and since 1999 is the incumbent of Josef Kryss Chair in Organic Chemistry. Prof. Rozen had many visiting-scientist appointments at DuPont Central Research Laboratories in the USA.

The achievements of Prof. Rozen were recognized by several prizes, the most recent one is this year American Chemical Society Award for "Creative Work in Fluorine Chemistry".

**The Israel Chemical Society Prize for Excellent Young Chemists  
for the year 2004 is awarded to  
Prof. Lucio Frydman  
the Weizmann Institute of Science**



for his outstanding achievements in the development of new NMR methods. Of particular importance are his contributions to the development of high-resolution solid-state NMR experiments and an ultra-fast multidimensional NMR methodology. These methods may find many applications in research, industry and medicine.

## פרסים לדוקטורנטים מצטיינים

**אוניברסיטת בן-גוריון : שמשון קלוש** - מעבירים קרינתיים ולא קרינתיים במערכות מולקולריות ודו-אטומיות, בהנחיית ד"ר בלהה שגב ופרופ' יהודה בנד.

**אוניברסיטת בר-אילן : טטיאנה פצ'ניק** - שחלופים סיגמטרופיים חדשים במערכות פרופרגיליות, אליליות ואלניות. מחקר מנגנוני ויישומים סינתטיים, בהנחיית פרופ' שמואל ברוורמן.

**האוניברסיטה העברית : גבריאל קרנר** - צבירים מתכתיים בגדלים ננומטריים על משטחים: ליתוגרפיה ומוביליות תלוית גודל, בהנחיית פרופ' מיכה אשר.

**אוניברסיטת תל-אביב : אביב חגולי** - פלואור מולקולרי כמכשיר מפתיע לפלואורנציה סלקטיבית של חומרים חשובים ביולוגית, בהנחיית פרופ' שלמה רוזן.

**אוניברסיטת תל-אביב : אופיר פלומנגום** - פיתוח תאוריות להבנת דינמיקה של מולקולות בודדות עם השלכות ביולוגיות, בהנחיית פרופ' יוסי קלפטר.

**הטכניון : מיכה פרידמן** - גישות חדשות לקראת פיתוח אנטיביוטיקות אמינוגליקוזידיות על בסיס נאומיצין, בהנחיית פרופ' טימור באזוב.

**מכון ויצמן למדע : סופרטיס גוהה ריי** - אינטראקציה של אלקטרונים איטיים עם מולקולות דנ"א, בהנחיית פרופ' רון נעמן.

**בסוף הכינוס חולקו גם פרסים לפוסטרים המצטיינים:**

**אודי שטיין**, האוניברסיטה העברית  
Laser patterning at the nanometer scale via buffer materials, בהנחיית פרופ' מיכה אשר.

**טאמר אנדראה**, הטכניון  
Organoactidine complexes mediate the coupling of terminal alkynes with isonitriles, בהנחיית פרופ' מוריס אייזן.

**The 2005 Wolf Foundation Prize in Chemistry to be awarded to**

**Richard Neil Zare, Stanford University, Stanford, CA, USA**

for his ingenious applications of laser techniques, for identifying complex mechanisms in molecules, and their use in analytical chemistry.

In making seminal contributions to the theory and practice of both physical and analytical chemistry, Zare has profoundly influenced developments in these two areas of science. He is an outstanding spokesman for science. In addition to his eminent contributions, he has worked relentlessly and successfully for chemistry on the national and international stage.

**The ACS Award for Creative Work in Fluorine Chemistry to**

**Shlomo Rozen, Tel-Aviv University**

**Was awarded at the 17th Winter Fluorine Conference,**

**January 2005, in St. Petersburg, FL**

The citation included the following remarks:

**Shlomo Rozen**, Professor of Organic Chemistry at Tel Aviv University, in Israel, has been "a tireless advocate" of using  $F_2$  and compounds derived from it as reagents in organic chemistry "He dispelled the myth that elemental fluorine is an uncontrollable strong oxidizer" and showed that "it is possible to perform some very selective reactions with elemental fluorine or difluoroacrylates, and other compounds. (see article by S. Rozen in Chemistry in Israel, 16, 7 (2004)).

**Scientific American chose**

**Micha Asscher, Hebrew University, Jerusalem**

as one of 50 scientists who "exhibited outstanding technology leadership in the realms of research, business and policymaking" during 2003-2004. The citation included the following:

**Nanostructures of nearly anything on anything else.**

Assembling wires and other intricate structures on any surface can prove tricky because not all materials combine well. If a substance is built onto another with which it interacts weakly, the top layer can ball up. Conversely, pairs of materials that interact strongly can bond too tightly to weave into sophisticated patterns. In May, Micha Asscher and his colleagues revealed a way to lay down a pattern of almost any substance on any other for novel nanometer scale devices such as those used in microelectronics and catalysts. Their method deposits a layer of inert xenon super cooled to a solid at roughly  $-250$  degrees Celsius, between two substances. When this sandwich is heated, the xenon evaporates and the bottom layer absorbs the top one. The researchers say their method could make conducting wires less than 30 nanometers wide yet millimeters long. (see article by M. Asscher in this issue).





## **Award for Service**

### **Professor Jean-Marie Lehn**

will receive the EuCheMS Award for Service, during the 10<sup>th</sup> Anniversary celebration of *Chemistry: a European Journal*, on Friday 15 April 2005, at the Institut de Science et d'Ingénierie Supramoléculaires (ISIS), Université Louis Pasteur, Strasbourg,

**in recognition of his significant contribution  
to European cooperation in chemical sciences**

Jean-Marie Lehn is Chairman of the Scientific Advisory Committee for the 1st European Chemistry Congress. The Congress will bring together chemical and molecular scientists from industry, academia and government institutions across Europe, and create a showcase for the latest research in chemical sciences. EuCheMS believes that academia and industry can work together in a concerted way to stimulate the competitiveness of European industry and help to achieve Europe's vision of a sustainable and competitive, knowledge-based economy. The Congress will be held on 27-31 August 2006 in Budapest [www.euchems-budapest2006.hu](http://www.euchems-budapest2006.hu)

Jean Marie Lehn is an enthusiastic contributor to many European chemical science initiatives, including the creation of pan-European chemistry journals such as "Chemistry - A European Journal", which are jointly owned by many European chemical societies. He was one of the sponsors of the AllChemE publication *Chemistry: Europe* and the future [www.allcheme.org](http://www.allcheme.org)

Jean-Marie Lehn received the Nobel Prize for Chemistry in 1987 for the development and use of molecules with structure-specific interactions of high selectivity. He is a passionate promoter of chemistry to young people, regularly giving lectures to pupils at high schools in France.

EuCheMS - European Association for Chemical and Molecular Sciences. [www.euchems.org](http://www.euchems.org)

**The 33rd Annual Meeting of the  
Israel Polymers and Plastics Society**

**was held on December 14, 2004,  
at the Azrieli Towers, Convention Center, Tel-Aviv.**

**Organizing Committee:**

**Dr. Nahum Rozenzweig**, Chairman, Eng. Moshe Goren, Secretary, Prof. Michael Silverstein, Dr. Alex Shouster, Prof. Arnon Siegman, President of the Society.

**The plenary Lectures were:**

Combinatorial methods for materials: what's new since Edison?

**Eric J. Amis**, Polymer Division, NIST, Gaithersburg, Maryland, USA.

Electronic devices based on semiconducting polymers confined into ordered inorganic host matrices  
**Gitti L. Frey**, Materials Engineering Department, Technion, Haifa.

Application of physicochemical characterization methods in polymers for failure evaluation, and development of new products

**Shmuel Baron**, TAMI – Institute for Research and Development, Haifa.

Recent developments in process-structure-property relationships in polymer processing

**Avraam I. Isayev**, Institute of Polymer Engineering, the University of Akron, Akron OH, USA.

**Seventeen lectures were delivered in parallel sessions in the following areas:**

Industrial Applications

Nano Composite Materials

Polymeric Micro-Structures

# GEORGE DE HEVESY (1885 1966): HAFNIUM AND RADIOACTIVE TRACERS

**Bob Weintraub, Director of the Libraries,**

**Sami Shamoon College of Engineering, Beersheva and Ashdod. [Bob@sce.ac.il](mailto:Bob@sce.ac.il)**

"Today, biologists and physicians using tracers in research and in diagnosis or treatment of disease, as well as research workers in many branches of physics, chemistry and technology, immediately associate the name of Hevesy with radioactive isotopes. Since the middle of our century and definitely at the time of Hevesy's death--isotopic tracers are being taken for granted in laboratories the world over. Radiation detectors, such as counters and scintillators, are standard equipment, and little thought is given to their historical and technical development; radioisotopes are available everywhere...It required Hevesy's vision and his unyielding efforts first to try out, gradually to develop, and finally to establish and expand a method that started with failure, but eventually became one of the most important and most extensively employed research tools of modern science" (H. Levi, 1967).

## **Radioactive Tracers**

George Hevesy was born in Hungary to Jewish parents. He earned his doctorate on the interaction of metallic sodium with molten sodium hydroxide under the direction of Georg Meyer in 1908 at the University of Freiburg (George de Hevesy: Hilde Levi, 1985, and references therein.).

In 1911 Hevesy went to Manchester to study techniques involving radioactive elements that were then being developed by Ernst Rutherford. Prof. Rutherford wanted to utilize the radioactive decay of radium-D for experiments, but needed first to separate this from the huge amount of lead that it was associated with in pitchblend.

In 1911 Rutherford said to Hevesy: "My boy, if you are worth your salt, you separate radium D from all that nuisance of lead". Hevesy: "In those days, I was an enthusiastic young man and, on immediately starting to attack the problem suggested to me, I felt quite convinced that I would succeed. However, although I made numerous attempts to separate radium D from lead and worked for almost two years at this task, I failed completely. In order to make the best of this depressing situation, I decided to use radium D as an indicator of lead, thus profiting from the inseparability of radium D from lead". Hevesy used the Radium D from the tubes in which radium emanation decayed to label small amounts of lead. "Hevesy's failure to separate those "chemically identical" elements and the conclusions he drew from his negative results became the turning point of his scientific career and the basis of his most significant contribution to science: namely, the use of radioactive isotopes as tracers" (H. Levi). Fritz A. Paneth had also made unsuccessful efforts to separate Ra D from lead. Paneth and Hevesy collaborated on the use of radium D as a tracer for lead and this led to lifelong friendship and collaboration.

## **Hafnium:**

In 1921 Hevesy went to Copenhagen to work with Niels Bohr. Bohr suggested to Hevesy, based on his quantum theory, to look for the as yet undiscovered element 72 in zirconium ores, to which it would be related. Previous efforts to find element 72 in trivalent rare earth residues failed, while Bohr maintained that in fact element 72 was similar to quadrivalent titanium. In 1923 Hevesy together with Dirk Coster, Professor of Physics and Meteorology at Copenhagen, announced the discovery of the element 72. This was achieved with the aid of x-ray techniques. The element was named Hafnium, the Latin name for Copenhagen. Levi: "This was a triumph for Hevesy and Coster who had overcome great experimental difficulties in order to prove that the unknown element 72 did not belong to the group of rare earths but

was indeed similar to zirconium. It was also a triumph for Bohr whose theory about the constitution of the atoms and the periodic table had found another striking, experimental confirmation. "

In 1923 Hevesy published the first results on the application of radioactive tracers to a biological study: lead uptake in the housebean (*Vicia faba*). In 1924, together with I.A. Christiansen and S. Lomholt, Hevesy reported the first application of radioactive tracers to animal physiology--the tracing of the circulation of bismuth injected into a rabbit. Bismuth was then being used in the treatment of syphilis.

Hevesy accepted a position at the University of Freiburg, where he remained from 1927-1934. Here he continued his biological studies. Among other work, Hevesy together with E. Hofer, demonstrated that there is a complete turnover of body water in the goldfish within a period of a few hours, and in humans after drinking water, that the water starts to appear in the urine within 26 minutes, and spends on the average 13.5 days in the body.

In 1933 Hevesy learned from Paneth, who then was a full Professor of Chemistry at Konigsberg, that he was "on leave" due to his Jewish background. Next among Hevesy's circle of friends and colleagues to be dismissed for similar reasons, were Kasimir Fajans and Victor Moritz Goldschmidt. Hevesy understood that he must leave Germany and left for Copenhagen to work at Neil Bohr's Institute.

### **Neutron Activation Analysis:**

In Copenhagen, Hevesy's one co-worker and assistant was Dr. Hilde Levi, a Jewish refugee from Germany with a Ph.D. in physics. In 1985 she wrote of this period (excerpts):

"The most important discovery from this short period of research was the basic development of neutron activation analysis. As discussed in a previous chapter, the separation and purification of the different elements within the group of rare earths was exceedingly complex. Chemists in many countries were still laboring with this problem using the classical methods of analytical chemistry. Hevesy suggested that--as a means of identification--we make use of the characteristic decay period of each of these elements and of their relative intensities of activation after neutron bombardment. In this way, their presence could be determined in any unknown mixture. In the early phase of this work we observed that, with the neutron sources available, the strongest activity was induced in the rare earth element dysprosium. It was therefore easy to detect even a minute amount of dysprosium compound present as an impurity in the salt of any other rare earth element. This finding was published in 1936. The classical test object Hevesy used one year later was a sample of gadolinium which Luigi Rolla of Florence has tried to purify from traces of Europium. We could see from the decay of the induced radioactivity that the sample consisted of two components decaying at different rates. Hevesy then added varying quantities of "impurity" to the purified gadolinium, and we compared the resulting changes in intensity of radiation from the two components. It was possible with this technique not only to identify the impurity but also to estimate how much of it was present...

While this exciting work with artificially produced radio-isotopes of the rare earths was in progress, Hevesy became more and more interested in the production of a radio-isotope of one of the lighter and biologically interesting elements. Radio-phosphorus seemed to be the obvious candidate. The first publication dealing with the new application of radioactive indicators described the pioneer experiment with P-22 injected into rats. This report had the form of a letter to the editor of Nature. It was submitted in September 1935 and signed by both Hevesy and Chievitz. The authors not only described the experiment and presented the results, they, that is to say Hevesy, made a rather sweeping statement which was not in agreement with the views widely held at that time. It reads: 'The results strongly support the view that the

formation of the bones is a dynamic process, continuously taking up phosphorus atoms which are partly or wholly lost again and are replaced by other phosphorus atoms..."

This pioneer experiment was a signal to biologists: while Hevesy's earlier application of the indicator method was of interest mainly to analytical chemistry, it was now the biologists' turn to learn what isotopic indicators are all about."

Hevesy, from the Nobel Lecture, 1944: "The most remarkable result obtained in the study of the application of isotopic indicators is perhaps the discovery of the dynamic state of the body constituents. The molecules building up the plant or animal organism are incessantly renewed. In the course of this renewal, not only the atoms and molecules taken up with the food participate, but atoms and molecules located in one organ or in one type of molecule will soon be found in another organ or in another type of molecule present in the same or in another organ. A phosphate radical taken up with the food may first participate in the phosphorylation of glucose in the intestinal mucosa, soon afterwards pass into the circulation as free phosphate, enter a red corpuscle, become incorporated with an adenosine triphosphoric acid molecule, participate in a glycolytic process going on in the corpuscle, return to the circulation, penetrate into the liver cells, participate in the formation of a phosphatide molecule, after a short interval enter the circulation in this form, penetrate into the spleen, and leave this organ after some time as a constituent of a lymphocyte. We may meet the phosphate radical again as a constituent of the plasma, from which it may find its way into the skeleton. Being incorporated in the uppermost molecular layer of the skeleton, it will have a good chance of being replaced by other phosphate radicals of the plasma or the lymph, but it may also have the good fortune to find a more or less lasting abode in the skeleton. This will be the case when it becomes embedded in a newly formed apatite-like crystallite..."

Germany occupied Denmark on April 9, 1940. In the summer of 1943, took place the rescue of the Danish Jews to Sweden by the heroic actions of the Danish people. Bohr, whose mother was Jewish, and Levi, were taken to Sweden. Hevesy left Denmark to Sweden by train on his Hungarian passport. Bohr moved on to England after a few days. Levi remained in Sweden until the end of the war.

In the fall of 1944 it was announced that Hevesy had been awarded the 1943 Nobel Prize in chemistry for his work on isotopes. Nobel laureates have the option of becoming Swedish citizens. Hevesy accepted Swedish citizenship and became a professor at the University of Stockholm.

"Adventures in Radioisotope Research: The Collected Papers of George Hevesy" appeared in 1962, containing English language reprints of 100 papers from George Hevesy's about 400 publications. The scope of Hevesy's work can be appreciated from the subject divisions in that collection:

Inorganic and Physical Chemistry: Analytical Applications, Activation Analysis, Electrochemistry, Interchange Studies, Self-diffusion, Tracers in the Search for Unknown Stable Elements.

Life Science: Application of Radioactive Tracers Occurring in Nature, Skeleton Studies, Phosphatides, Acid Soluble Phosphorous Compounds, Fatty Acids, Permeability Studies, Labeling of Red Corpuscles, Clinical Investigations, Iron Metabolism, Nucleic Acids, Studies in Radiation Biology, Botanical Studies.

Hevesy, 1958: "When we started with Paneth in the first days of 1913 to apply radium D as a tracer of lead, the word "isotope" was not yet coined. Groups of radioactive substances such as mesothorium and radium, or ionium and thorium, were denoted by Soddy as "chemically inseparable elements". Much has happened since those days!"

## פרופסור חוה ליפשיץ 1936 - 2005



קהילת הכימאים בישראל ספגה אבדה גדולה עם מותה בטרם עת של פרופ' חוה (אווה) ליפשיץ ב-1 במרץ, 2005. חוה ליפשיץ היתה מדענית מובילה בקנה מידה בינלאומי בתחום המס ספקטרומטריה, היא בלטה כדמות מרכזית בעיצוב המכון לכימיה באוניברסיטה העברית בירושלים, ומלאה תפקידים חשובים שהשפיעו על עיצוב מדיניות ההשכלה הגבוהה בישראל.

חוה ליפשיץ (לבית וולף) נולדה בווינה ב-1936, ובאה ארצה כילדה. את כל לימודיה בכימיה עשתה באוניברסיטה העברית בירושלים. את תואר הדוקטור, על מחקר בכימיה של קרינות, בהנחיית פרופ' גבריאל שטיין, קבלה ב-1961. לאחר מכן יצאה להשתלמות פוסט-דוקטוראלית (1961 עד 1963), במעבדתו של פרופ' פרנק לונג, באוניברסיטת קורנל. שלב זה מציין את

כניסתה לתחום המס ספקטרומטריה, בו היא פתחה את דרכה המדעית, ובו הגיעה להישגים גדולים. היא חזרה לישראל ב-1963, הצטרפה לסגל האוניברסיטה העברית בירושלים, ובנתה מעבדת לתפארת למחקר במס ספקטרומטריה. היא הצליחה לפתח קריירה פורחת, ובו בזמן גידלה משפחה עם שלושה ילדים ביחד עם בעלה אסא. היא עסקה במחקר יצירתי, טיפחה את קבוצת המחקר שלה והחזיקה בעמדות אוניברסיטאיות בעלות חשיבות בעוז רוח, בהחלטיות, ובהצלחה רבה. למחקריה היתה השפעה ניכרת בתחומים הכוללים את הכימיה והדינמיקה הכימית של יונים בפזה הגזית, ריאקציות חד-מולקולריות ומנגנוניהן; נתיבי הפירוק של צברים יוניים; כימיה של פולרנים וכן מולקולות ביולוגיות בפזה הגזית. היא היתה

חברה בוועדות העריכה של עיתונים מקצועיים נחשבים בתחום, ובכללם Mass Spectrometry Reviews ו-International Journal of Mass Spectrometry שגם פרסם גליון מיוחד לכבודה בשנת 1997. בין הפרסים שבהם זכתה היו פרס מקס-פלנק מטעם קרן אלכסנדר פון-הומבולדט (1991) ופרס החברה הישראלית לכימיה לשנת 2003.

חוה ליפשיץ היתה מנחה רבת-השראה של דוקטורנטים ופוסט-דוקטורנטים, ורבים מאלה שחינכה מחזיקים כיום בעמדות חשובות במכוני מחקר, אוניברסיטאות, ובתעשיות מתקדמות. היא כהנה במספר וועדות ציבוריות חשובות, ובכללן המועצה להשכלה גבוהה. במסגרות הללו היא היתה קול רם וסמכותי שתמך בחשיבות המחקר ובהקצאת משאבים למחקר. היא גם גייסה את האנרגיות הרבות שלה לתמיכה במדעניות צעירות ומוכשרות, ולגיוסן למערכת האקדמית. מדעניות צעירות, בבניית הקריירה שלהן, מצאו בה אישיות תומכת ומסייעת, ומודל רב-השפעה ללכת בעקבותיו.

בגיל צעיר יחסית חלתה בסרטן. היא לחמה במחלה בנחישות נדירה אבל המשיכה בעבודת המחקר שלה, בעניין ובהתלהבות עד ימיה האחרונים, למרות ייסורי המחלה.

חוה ליפשיץ הותירה עם לכתה את בעלה, פרופ' אסא ליפשיץ, שגם הוא במכון לכימיה באוניברסיטה העברית, ושלושה ילדים שאחד מהם ד"ר רון ליפשיץ הוא פיסיקאי תיאורטי באוניברסיטת תל-אביב.

פרופ' בני גרבר, האוניברסיטה העברית

## **Professor Chava Lifshitz 1936 – 2005**

The chemical community in Israel sustained a great loss with the untimely death of Prof. Chava (Eva) Lifshitz on March 1, 2005. She was a leading mass spectrometrists; a prominent figure in shaping the Institute of Chemistry of the Hebrew University of Jerusalem, and she held important positions that affected the high education policies in Israel.

Chava Lifshitz (nee Wolf) was born in Vienna, in 1936, and came to Israel as a child. She got her undergraduate and graduate training at the Hebrew University of Jerusalem. She received her Ph.D. in 1961, for work on radiation chemistry, with Prof. Gabriel Stein. She then pursued postdoctoral studies (1961-1963) with Prof. Frank A. Long, at Cornell University. It was at this stage that she entered the field of mass spectrometry, in which she developed her career and reached major accomplishments. She returned to Israel in 1963, joined the Faculty of Sciences at the Hebrew University and built a mass spectrometric laboratory. Chava developed a highly successful career, while at the same time raising a family of three young children, together with her husband, Assa. She carried out creative research, developed her research group and held high university offices with great determination of spirit, and with remarkable success. She had an important impact in areas that include chemistry and chemical dynamics of ions in the gas phase; unimolecular reactions and their mechanisms; fragmentation pathways of molecular ion clusters; fullerene chemistry and biological molecules in the gas phase. She served on the editorial boards of the International Journal of Mass Spectrometry (IJMS) and of Mass Spectrometry Reviews. In 1997, the IJMS published a special issue in her honor. Among the awards that she received for her research are the Max Planck Award of the Alexander von Humboldt Foundation (1991) and the Israel Chemical Society Prize (2003).

Chava Lifshitz was a superb mentor, and many students she trained hold prominent positions at research institutions, universities and the hi-tech industry. She served on several important advisory bodies, including the Israel Board of Higher Education, and was a forceful voice for the importance of scientific research and its funding. She also mobilized her energies for recruiting capable women scientists to academic positions, and for the need to increase the presence of women on the faculty. Young women scientists trying to develop academic careers found her a source of support and an inspiring role-model. At a relatively young age, she was afflicted with cancer. She fought the illness with dauntless courage and determination, while continuing her research and her intense interest and enthusiasm for science to her very last days.

Chava Lifshitz is survived by her husband, Prof. Assa Lifshitz, who is also on the faculty of the Institute of Chemistry, at the Hebrew University of Jerusalem, and by three children, one of them, Dr. Ron Lifshitz, is a theoretical physicist at Tel-Aviv University.

Prof. Benny Gerber, the Hebrew University.



## **"Living Polymers" 50 years of evolution**

**Moshe Levy**, Department of Materials and interfaces, The Weizmann Institute of Science, Rehovot

The term "Living Polymers" was first introduced in a short communication by Szwarc, Levy and Milkovich, (JACS 78, 2656, 1956) and is now widely used in the polymer literature. It led to synthesis of **Monodisperesed polymers, Telechelic polymers and Block copolymers.**

Living polymerization has evolved in the last 50 years and conditions were discovered for various other types of anionic, cationic, ring-opening and free radical systems. The field has expanded tremendously and the term "controlled/living" polymerization is commonly used to cover all the methods.

Some of the interesting developments in the area, discussed in the paper, include:

Thermoplastic elastomers; macromonomers and polymer brushes; "Knitting Pattern" morphology in a tri-block polymer; nanoscopic structures; functionalization of carbon nanotubes; diblock copolymer nanofibers; monodispersed dendronized polymers with extremely high MW; functional supramolecular inorganic polymeric materials; new polyolefin architectures using Ziegler-Natta living polymerization; living photo-polymerization; propagation of both ends of a polymer chain with two monomers by two different living/controlled methods – ROP and ATRP and block copolypeptides.



## **New Chemistry of the Noble Gas Elements: Novel Molecules, Polymers and Cluster**

**R.B. Gerber**, Department of Physical Chemistry, Hebrew University of Jerusalem and Department of Chemistry, University of California, Irvine CA, U.S.A.

There have been exciting developments in noble gas chemistry in recent years. This paper describes the theoretical contributions of our research group to a new important family of the noble gas compounds. The results presented include:

- (1) Determination of the formation mechanisms of the new compounds, produced photochemically in cryogenic solids, by simulations of the dynamics;
- (2) Prediction of the stability of  $\text{HHeF}$  in pressurized solid helium – as a first stable compound of helium;
- (3) Prediction of compounds made of noble gas atoms and hydrocarbons, especially derivatives of acetylene, e.g.  $\text{HXeCCH}$ ,  $\text{HXeCCXeH}$ . These compounds were prepared experimentally in the laboratories of Räsänen (Helsinki) and Feldman (Moscow) following the prediction, and this development is having a major effect on noble gas chemistry. Progress and new opportunities in this area are discussed;
- (4) A polymer made of xenon and carbon, with the repeat unit –  $(\text{XeCC})$  – is predicted to be stable. The interesting properties of this first noble-gas extended polymer are discussed;
- (5) The stability of molecular crystals made of noble gas compounds such as  $\text{HXeCCH}$  is predicted. This may open a range of new cryogenic materials. Finally, prospects and opportunities for new developments in noble gas chemistry in the near future are pointed out.

## **Pulse laser patterning of metallic thin films assisted by weakly bound buffer layers**

**Gabriel Kerner, Ori Stein and Micha Asscher**, Department of Physical Chemistry, Hebrew University of Jerusalem

The Buffer Layer Assisted Laser Patterning (BLALP) method is presented, for patterning metallic layers on surfaces, using laser desorption of weakly bound buffer material, e.g.  $\text{Xe}$ ,  $\text{CO}_2$  or  $\text{H}_2\text{O}$ . This technique utilizes a low power laser pulse used in order to pattern metallic thin film. The BLALP method was developed in two complementary pathways, 'positive' and 'negative' procedures. It is discussed as a potential alternative for standard photo-lithography, promising a cleaner, faster and therefore more cost effective and environmentally friendlier than current procedures.

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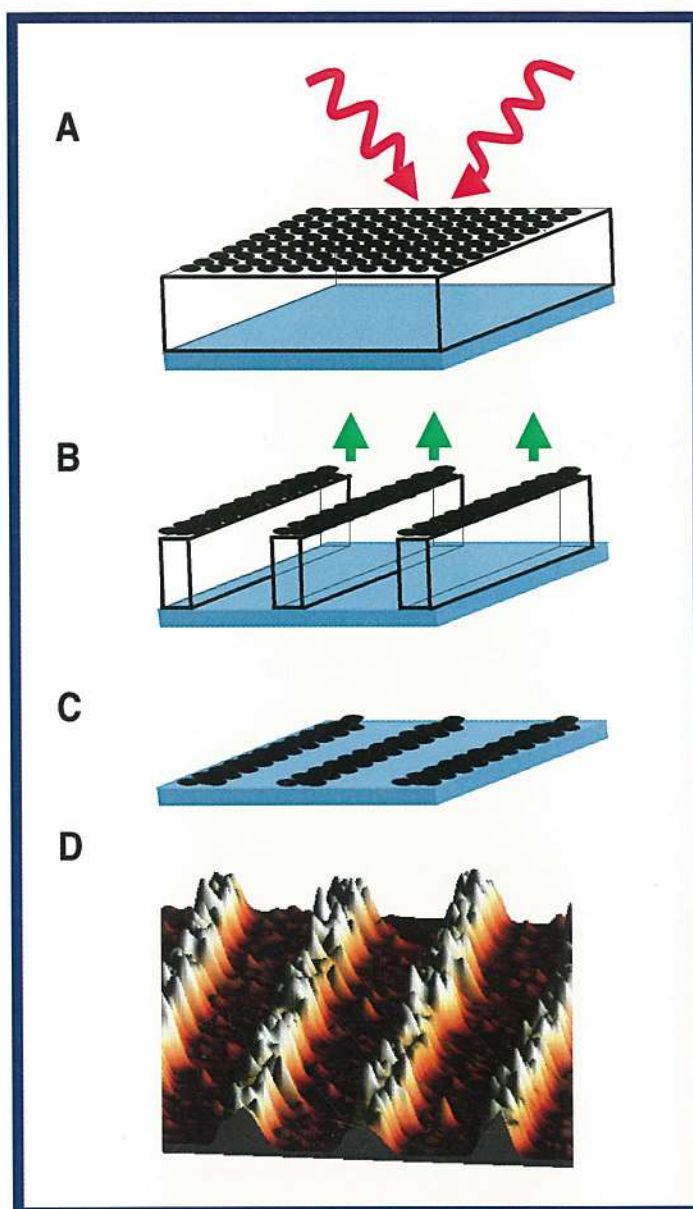
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**A Schematic view of the buffer layer assisted  
laser patterning (BLALP)**  
(see article by M. Asscher page 15)