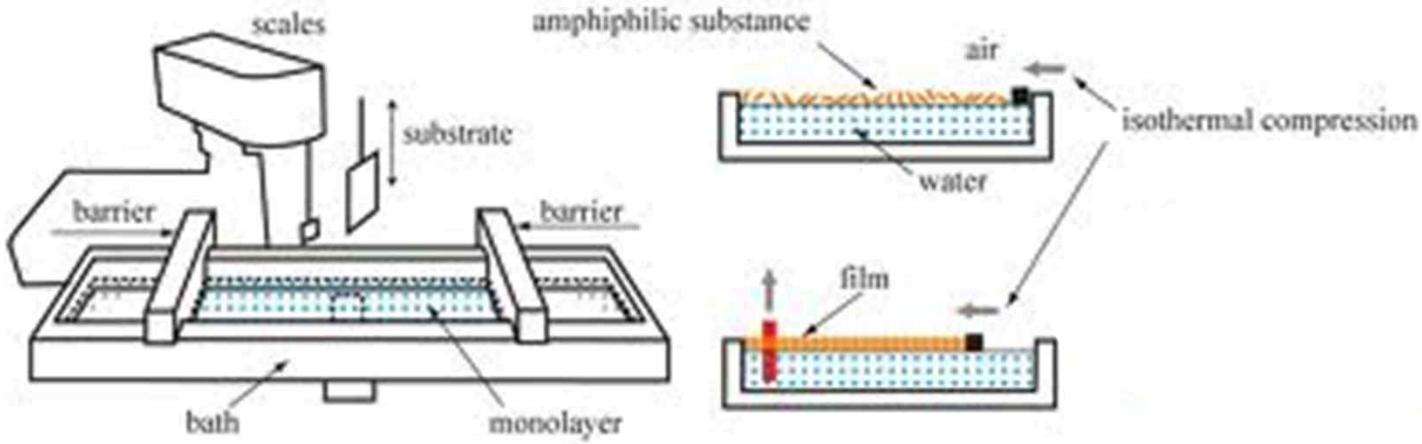
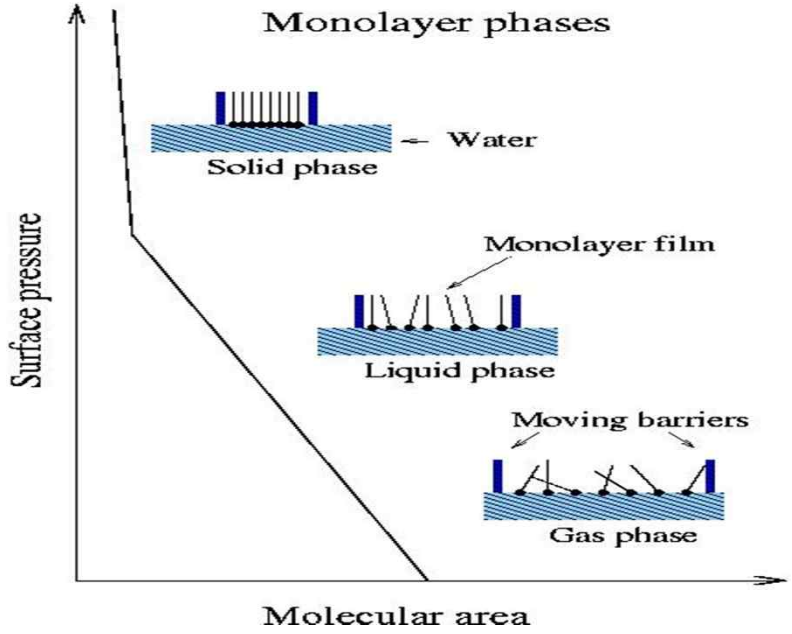
Self-Assembled Monolayers and Soft Lithography

Summarized by
Prof. Dong June Ahn
Korea University

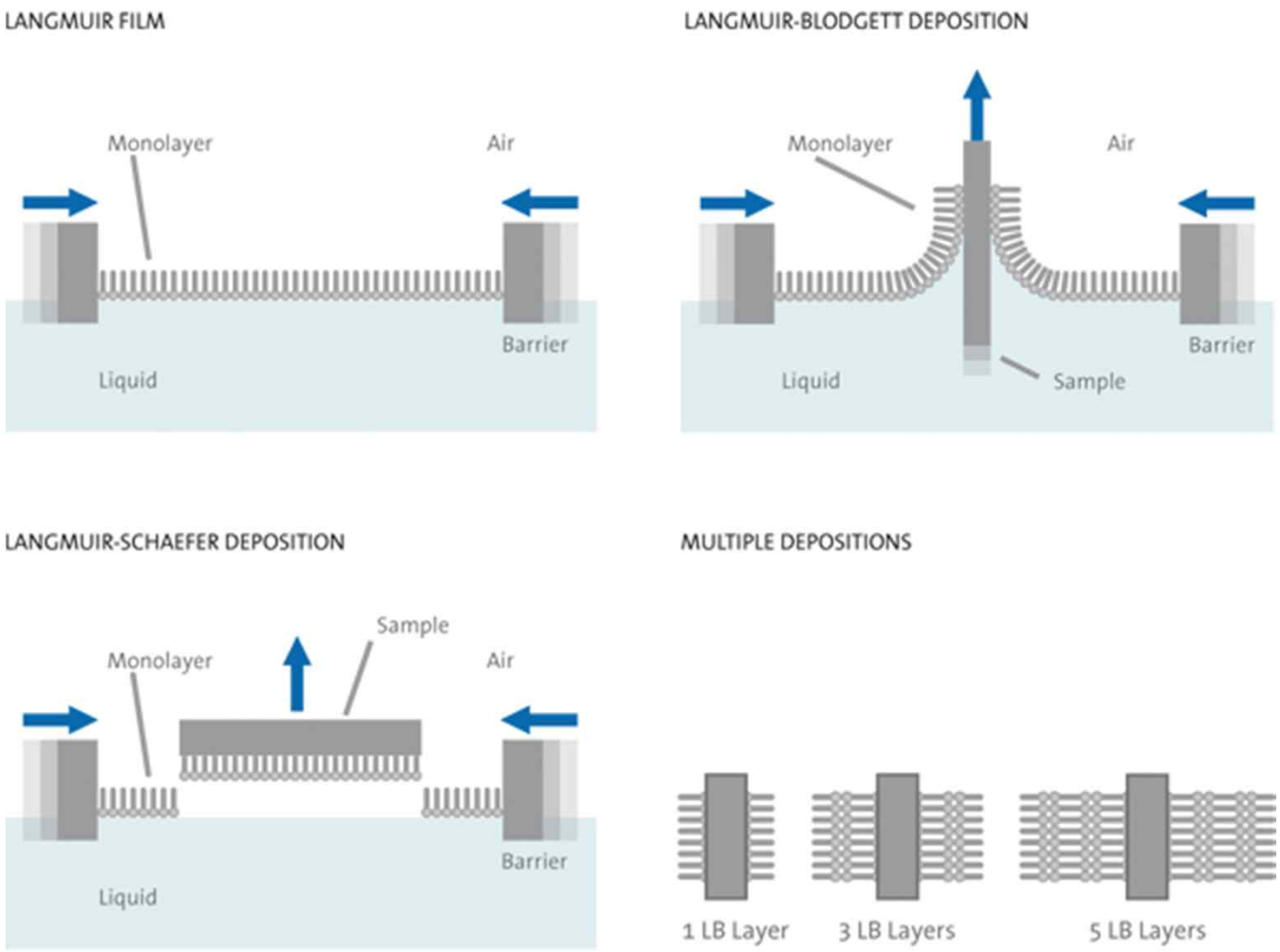
Langmuir Monolayer





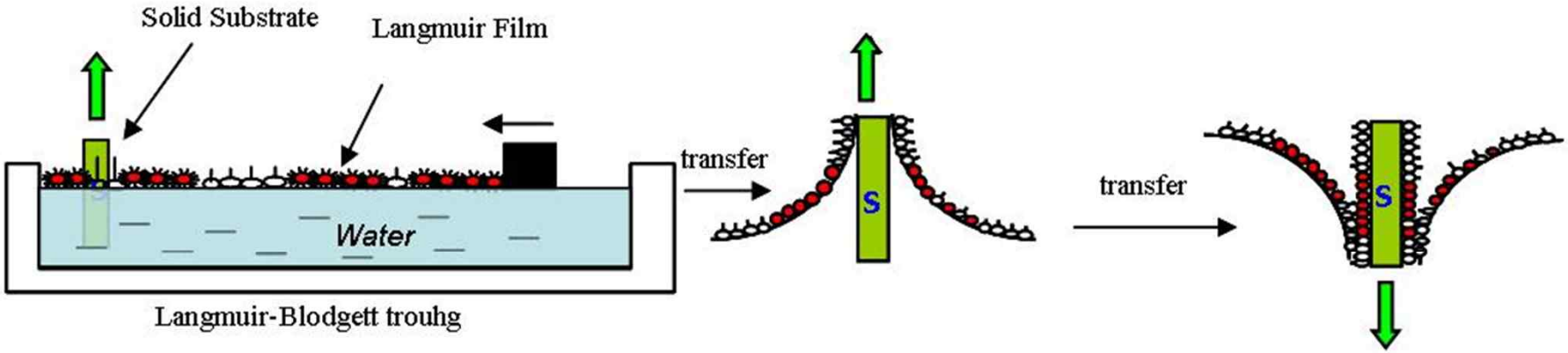
Franklin, Pockels, Langmuir, Gaines

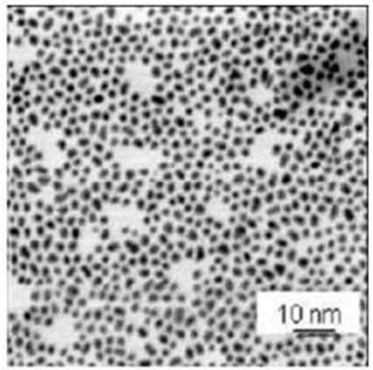
Langmuir-Blodgett Deposition



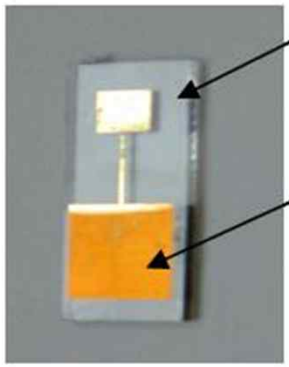
Langmuir, Blodgett, Schaeffer
Kuhn, Swalen, Allara, Petty, Roberts

LB Deposition for Nanoparticles





Nanoparticules
Monolayer

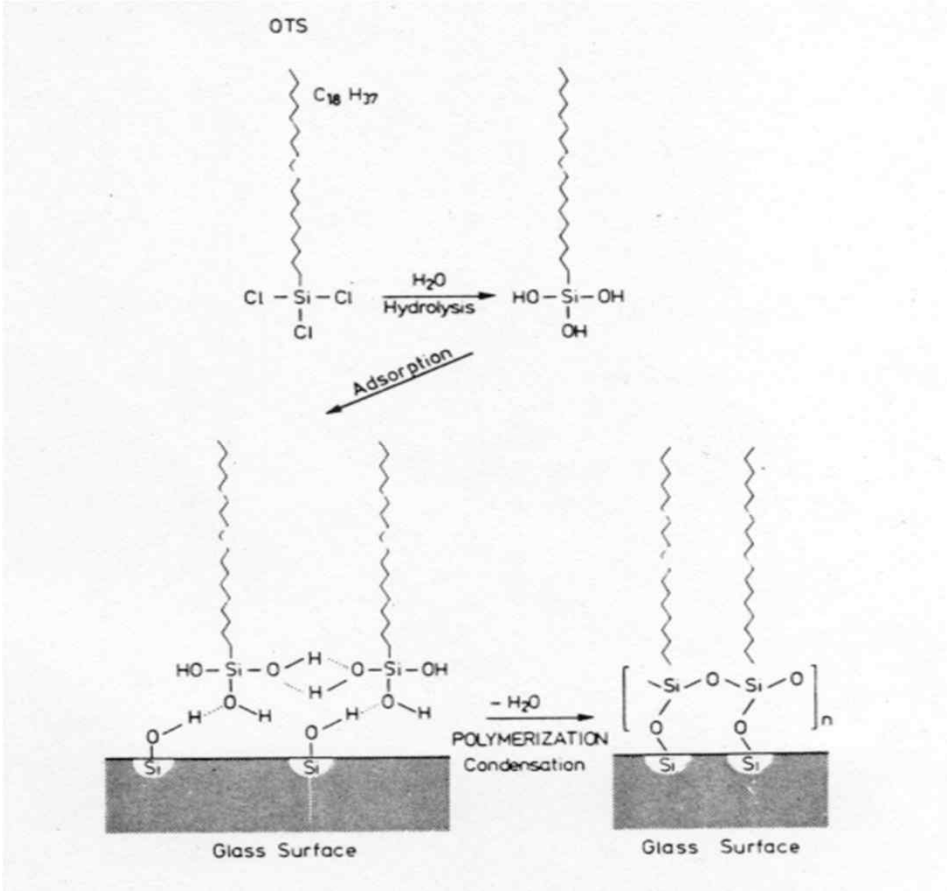


Glass substrate
with gold
electrode

Nanostructured film

Self-Assembly of Alkyl Silanes

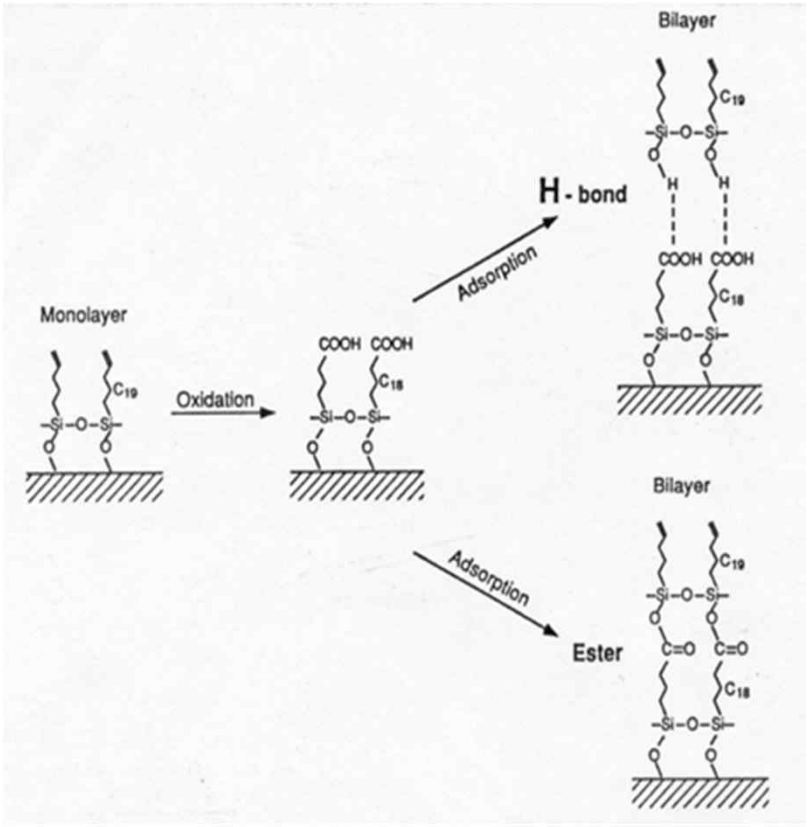
Sagiv, JACS (1980)



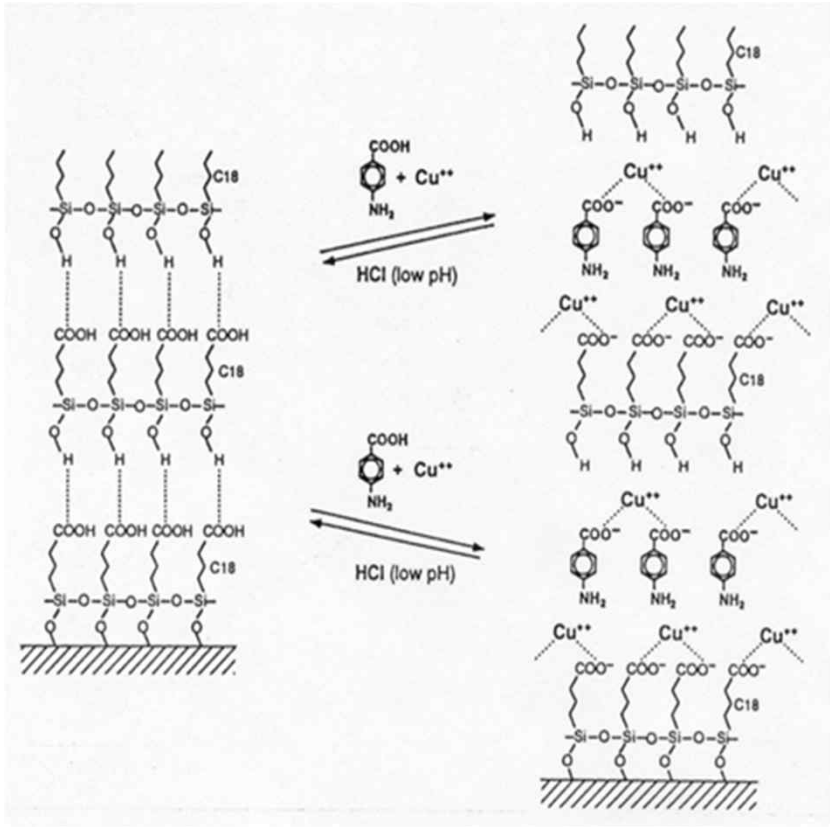
1st generation

Self-Assembly of Alkyl Silanes

Sagiv, JACS (1983)

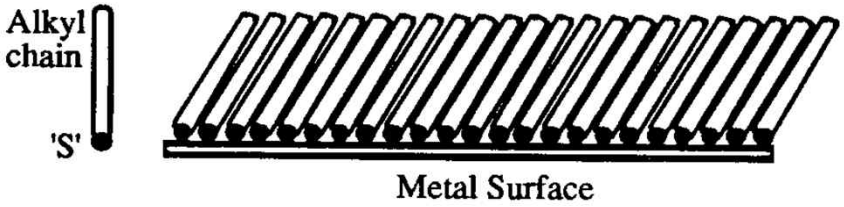


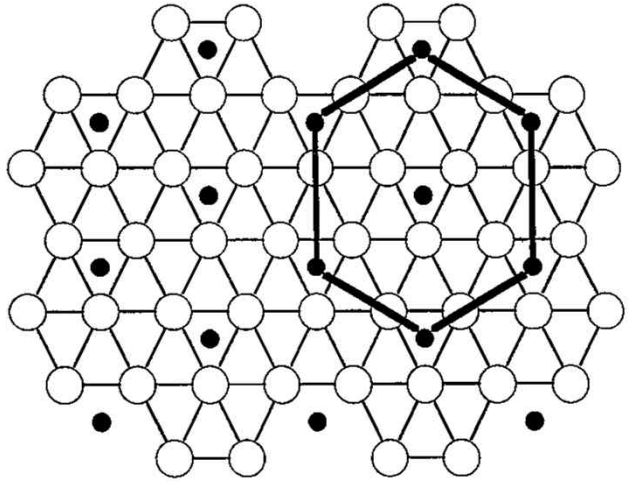
2nd generation

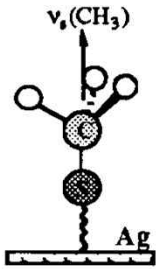


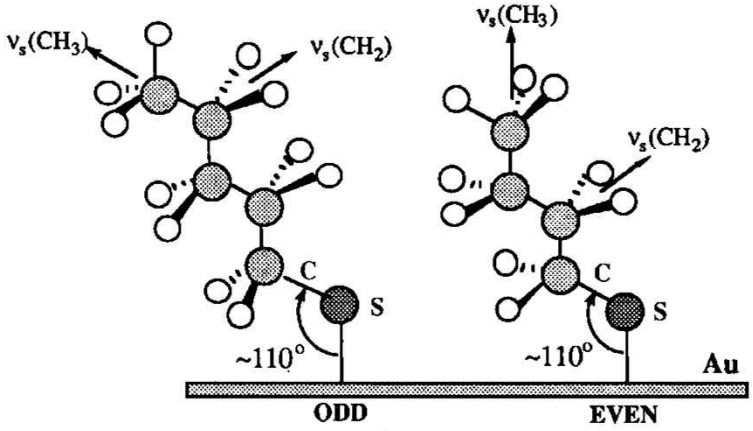
3rd generation

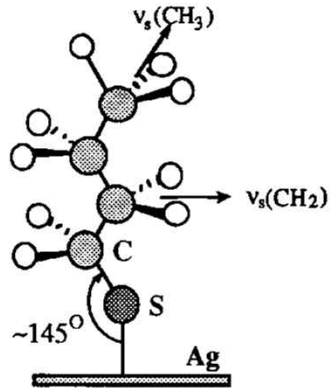
Self-Assembly of Alkyl Thiols









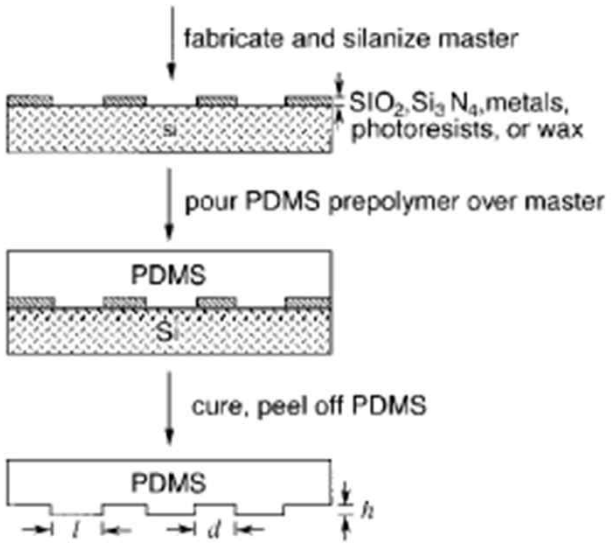


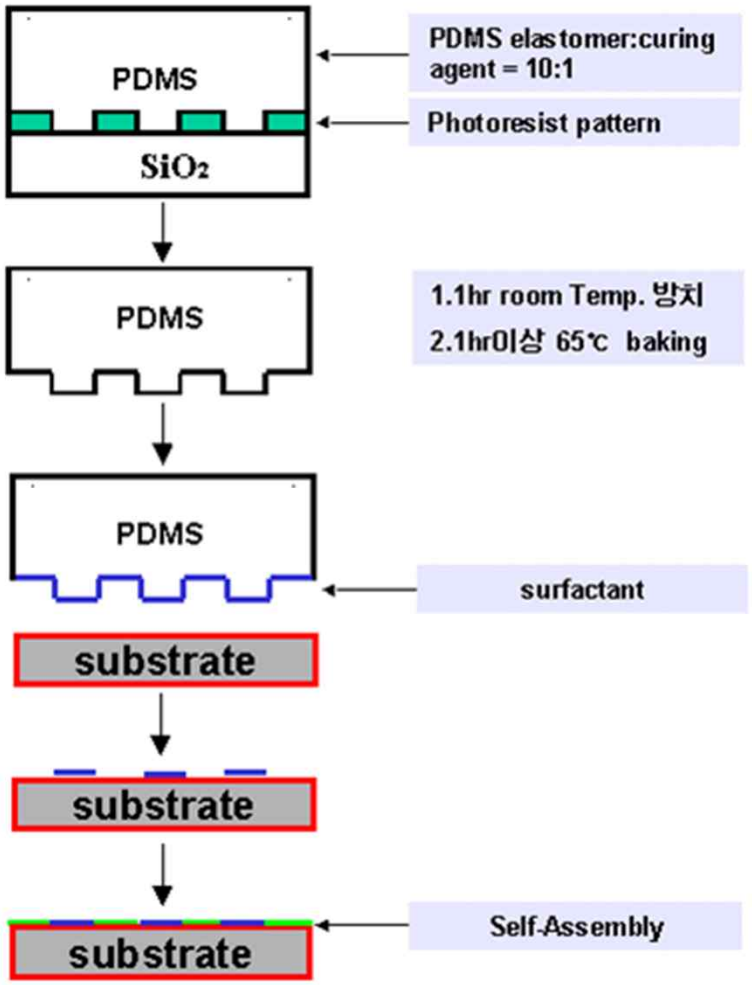
Nuzzo, Ulman, Whitesides

Table 4. Substrates and ligands that form SAMs.

Substrate	Ligand or Precursor	Binding	Ref.
Au	RSH, ArSH (thiols)	RS–Au	[39, 46, 47]
Au	RSSR′ (disulfides)	RS–Au	[39, 46, 48]
Au	RSR′ (sulfides)	RS–Au	[39, 46, 49]
Au	RSO_2H	RSO_2–Au	[50]
Au	R_3P	R_3P–Au	[51]
Ag	RSH, ArSH	RS–Ag	[39, 52]
Cu	RSH, ArSH	RS–Cu	[39, 53]
Pd	RSH, ArSH	RS–Pd	[39, 54]
Pt	RNC	RNC–Pt	[39, 55]
GaAs	RSH	RS–GaAs	[56]
InP	RSH	RS–InP	[57]
SiO_2, glass	$RSiCl_3$, $RSi(OR')_3$	siloxane	[39, 46, 58]
Si/Si–H	$(RCOO)_2$ (neat)	R–Si	[59]
Si/Si–H	$RCH{=}CH_2$	RCH_2CH_2Si	[60]
Si/Si–Cl	RLi, RMgX	R–Si	[61]
metal oxides	RCOOH	$RCOO^- \cdots MO_n$	[62]
metal oxides	RCONHOH	$RCONHOH \cdots MO_n$	[63]
ZrO_2	RPO_3H_2	$RPO_3^{2-} \cdots Zr^{IV}$	[64]
In_2O_3/SnO_2 (ITO)	RPO_3H_2	$RPO_3^{2-} \cdots M^{n+}$	[65]

Micro-Contact Printing (μCP)





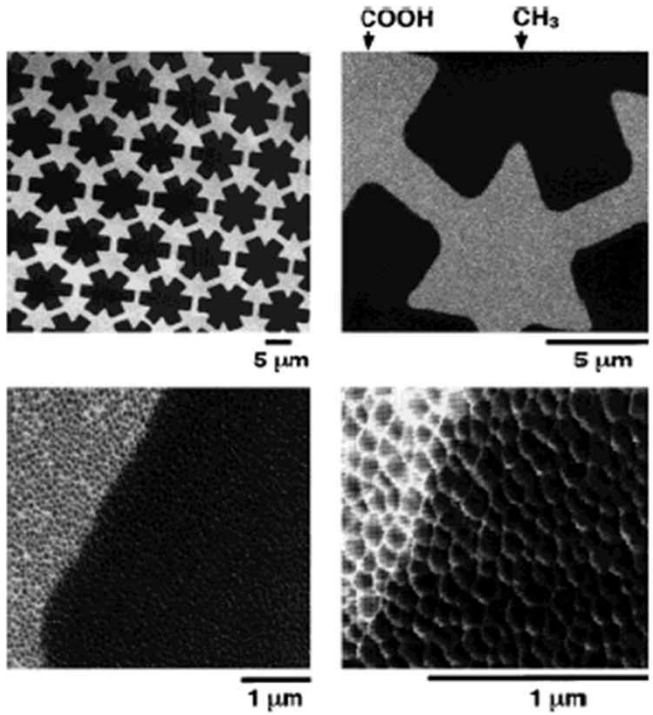
Soft Lithography

Y. Xia

G. M. Whitesides

Xia & Whitesides, *Angew. Chem. Int. Ed.*, 37, 550 (1998).

Microcontact Printing (μCP) on Gold



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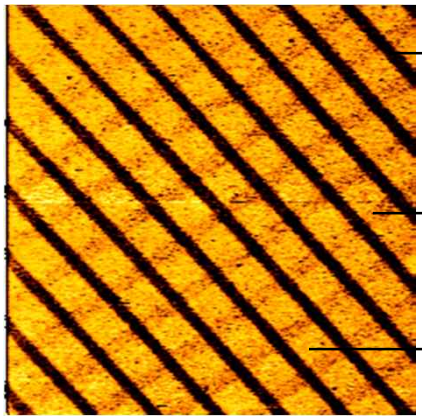


HDT (-CH_3)

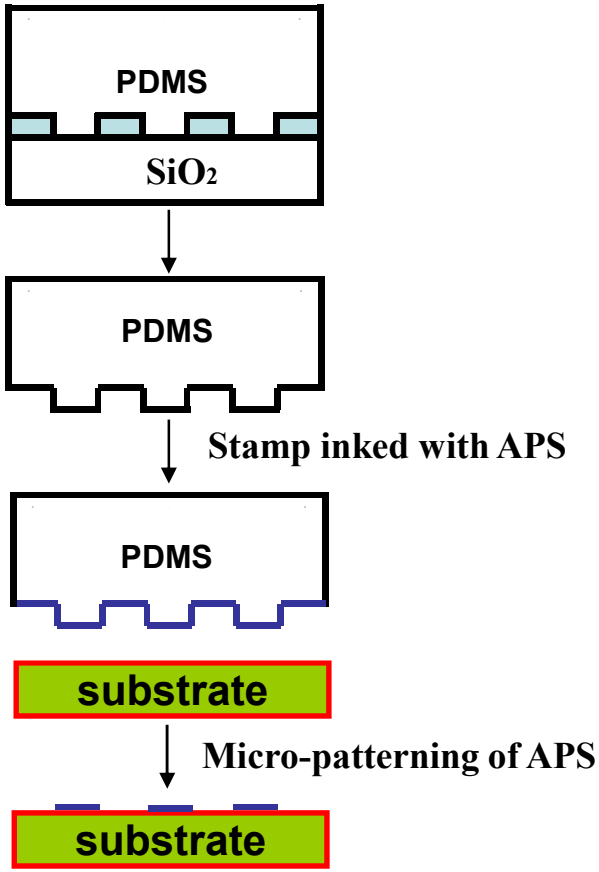
MUOH (-OH)

MHA (-COOH)

70 μm

Microcontact Printing (μCP) on Glass

APS : 3-Aminopropyltriethoxysilane



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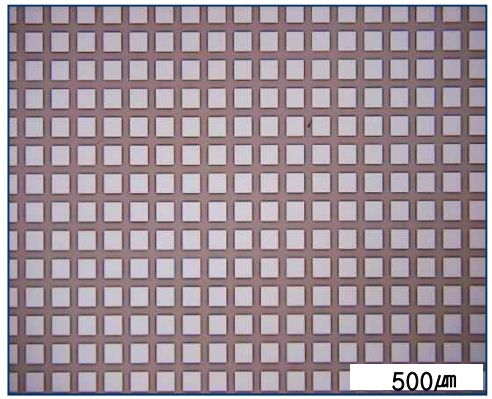

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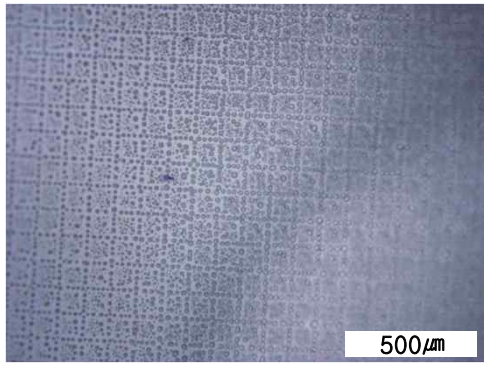
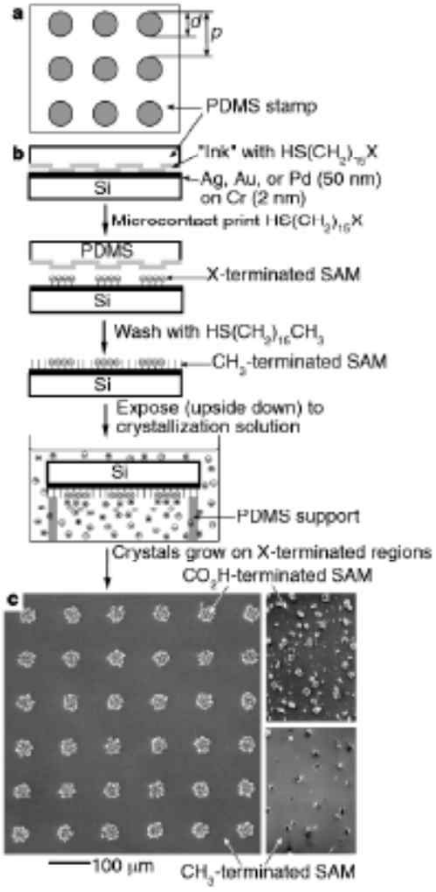
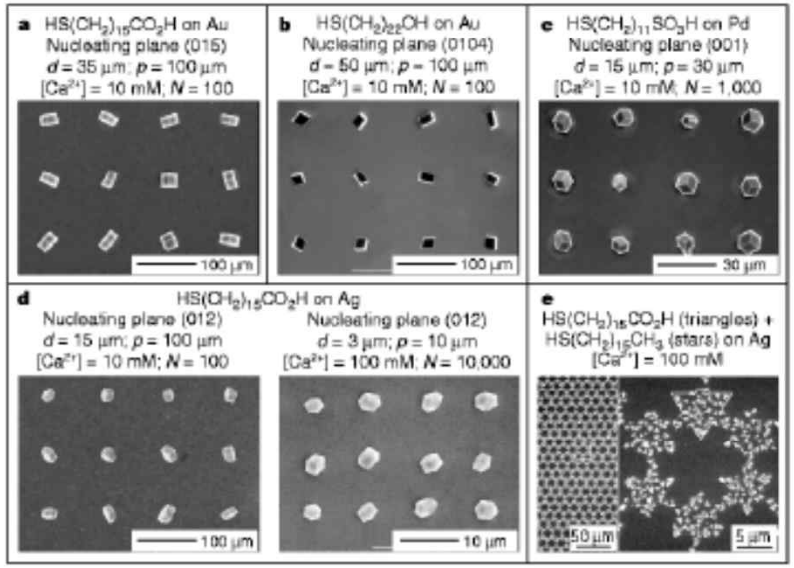


Self-assembled monolayer (SAM) and μCP

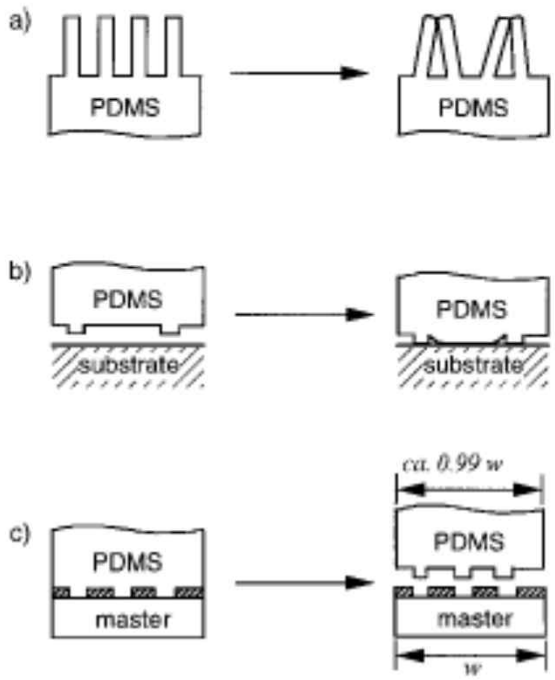
❑ Crystal growth

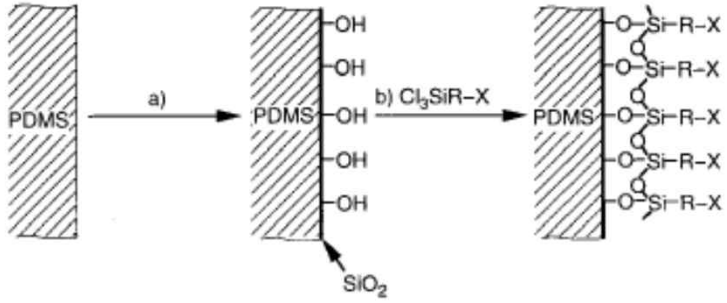




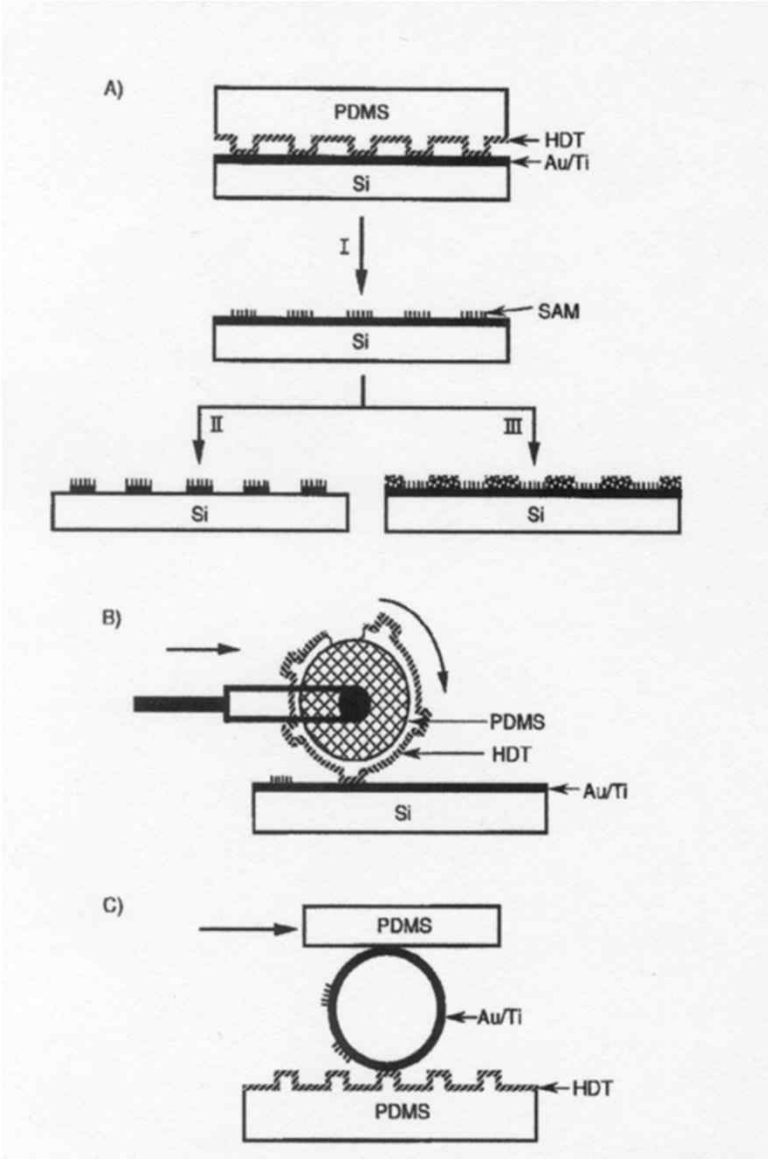
Whitesides et al., *Nature*, **398**, 495 (1999)

Regarding PDMA Stamps





μCP : Variation



μCP : Evolution

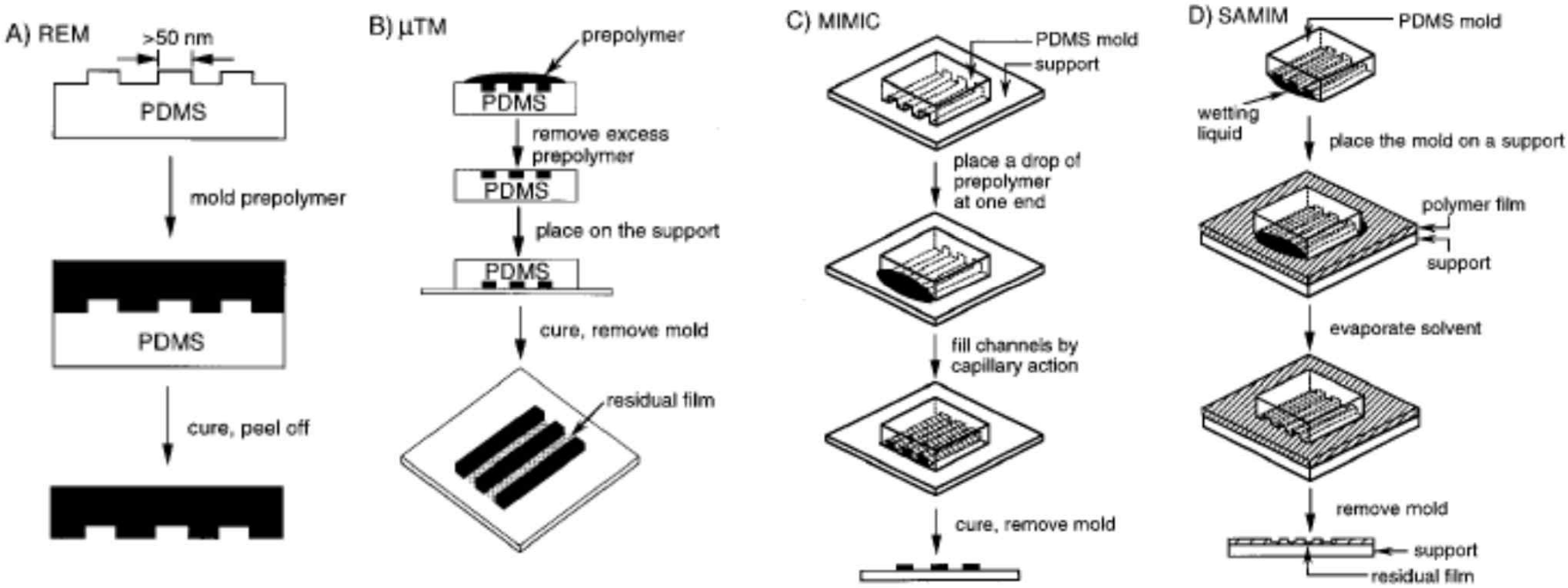
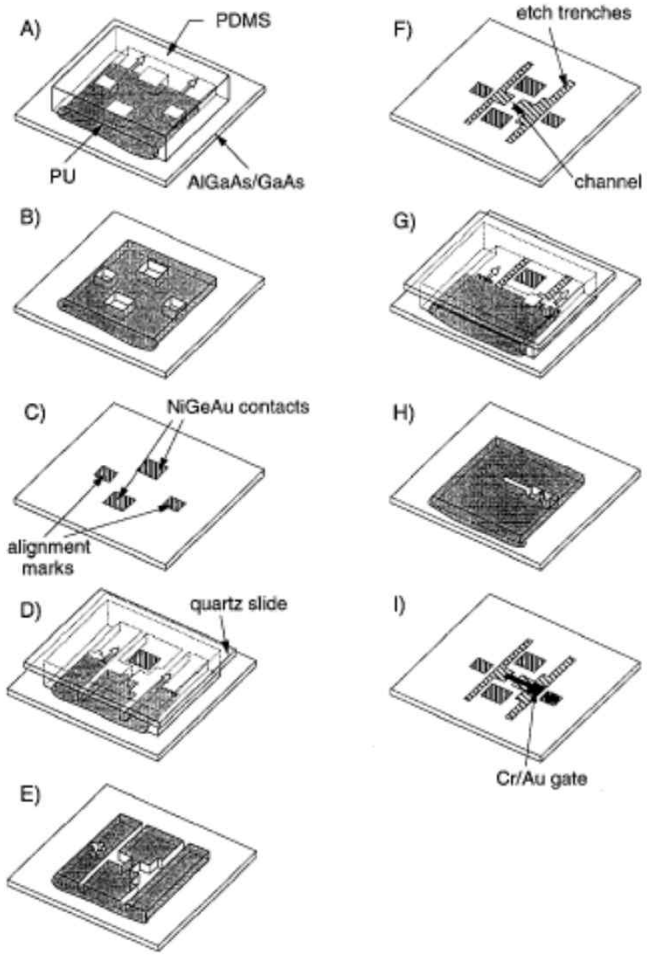
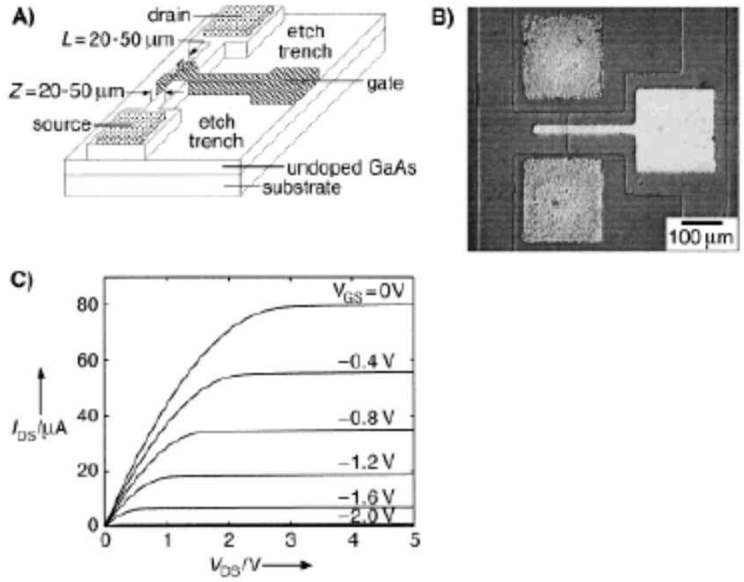


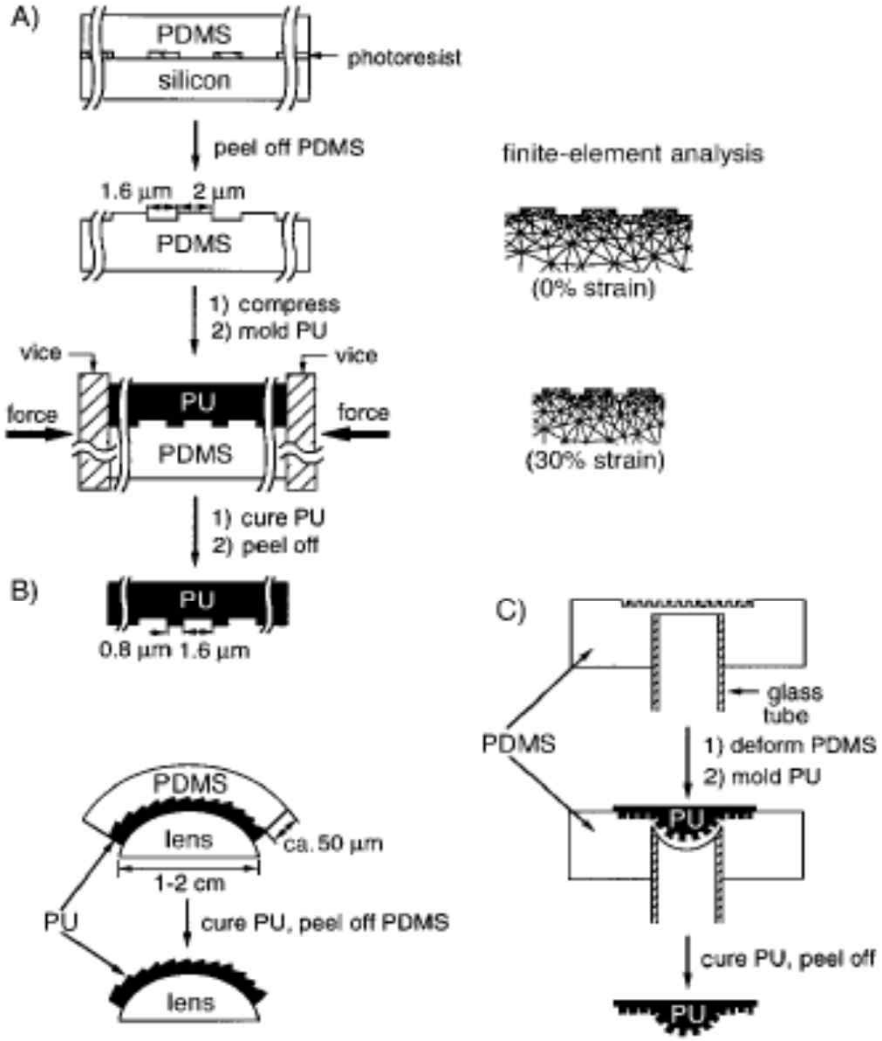
Figure 17. Schematic illustration of procedures for A) replica molding, B) microtransfer molding, C) micromolding in capillaries, and D) solvent-assisted micromolding.

μCP : Electronics





μCP : Evolution to 3D



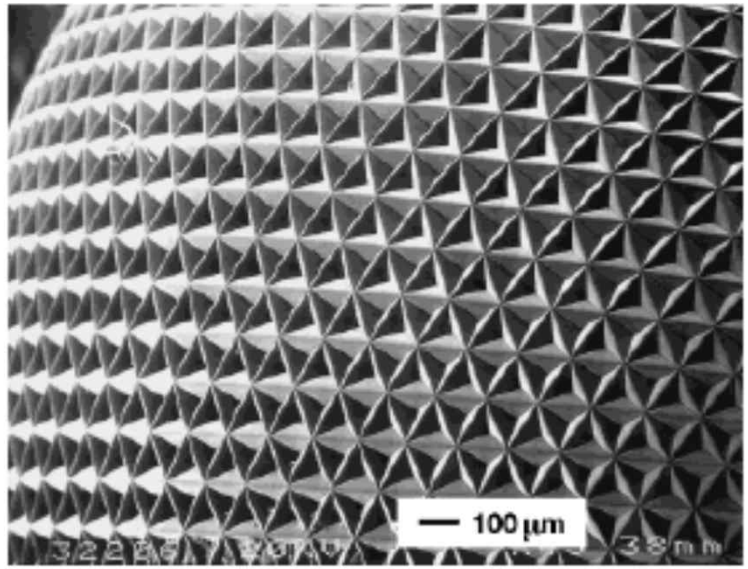
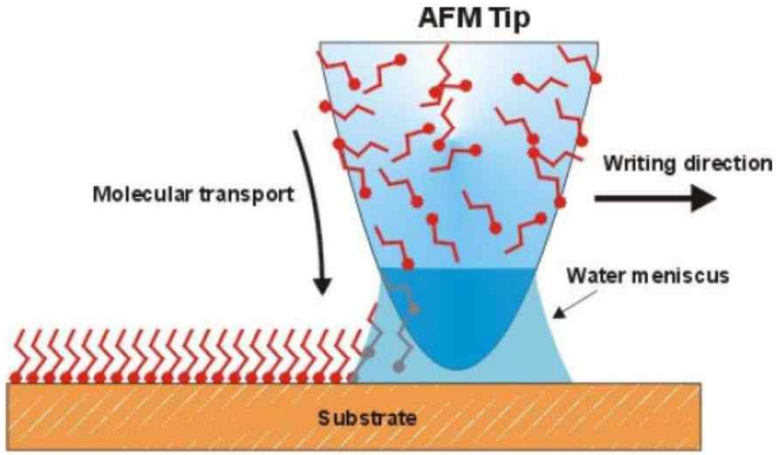


Figure 21. Schematic illustration of procedures for replica molding against elastomeric PDMS molds under A) mechanical compression, B) bending, and C) stretching.[35] The reconfigurated surfaces in PDMS are replicated with a UV-curable prepolymer of PU.

Dip-pen nanolithography의 개념

□ Mirkin박사는 AFM측정에서 극복해야 할 단점인 대기 중의 물분자의 기판으로의 이동을 이용하여 코팅하고자 하는 물질을 물과 함께 이동가능성을 생각



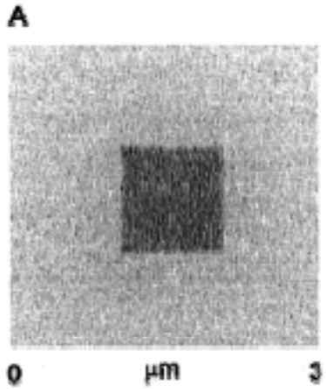
AFM tip을 이용한 물질전달 개념도

Fountain pen

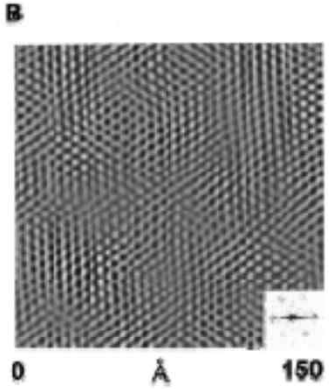
□ 만년필과 DPN의 비교

DPN	Fountain pen
AFM tip	Nib (end part of pen)
Solid substrate	Paper
Molecules	Ink

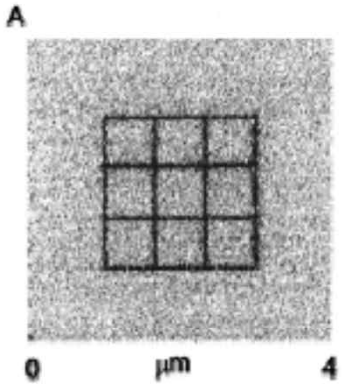
Mirkin, Ginger, and Zhang, *Angew. Chem. Int. Ed.*, 43, 30 (2004).

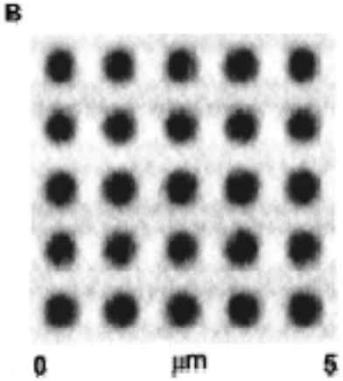


Amorphous Au

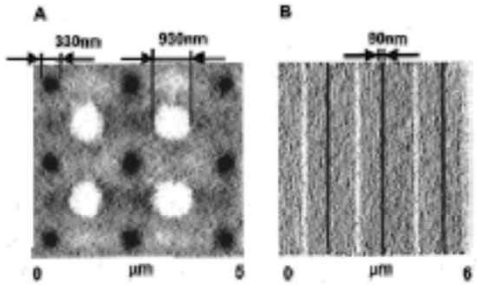


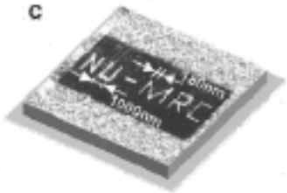
Au (111)



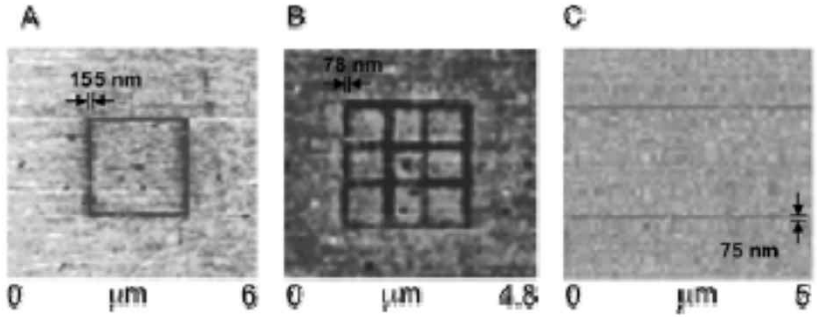


Amorphous Au





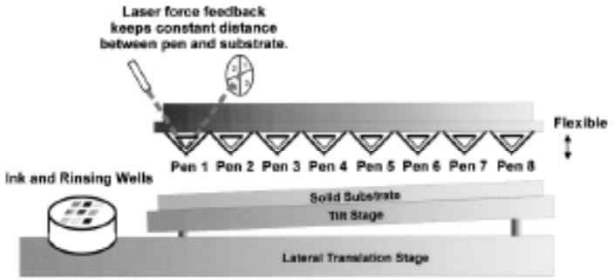
Amorphous Au

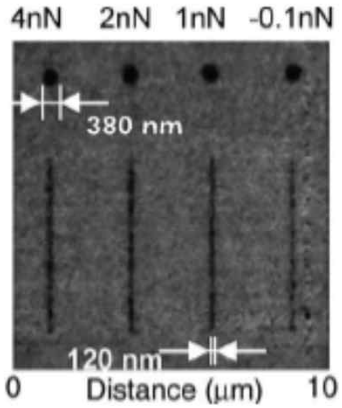


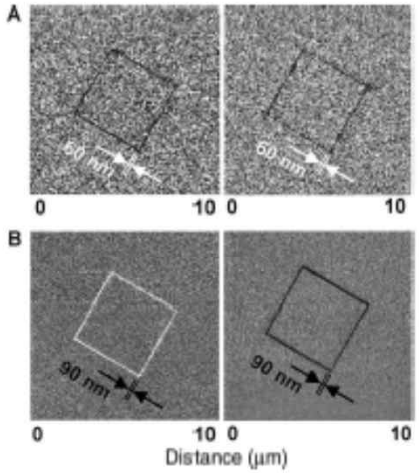
HMDS (hexamethyldisilazane) : $(H_3C)_3$-Si-NH-Si-(CH_3)

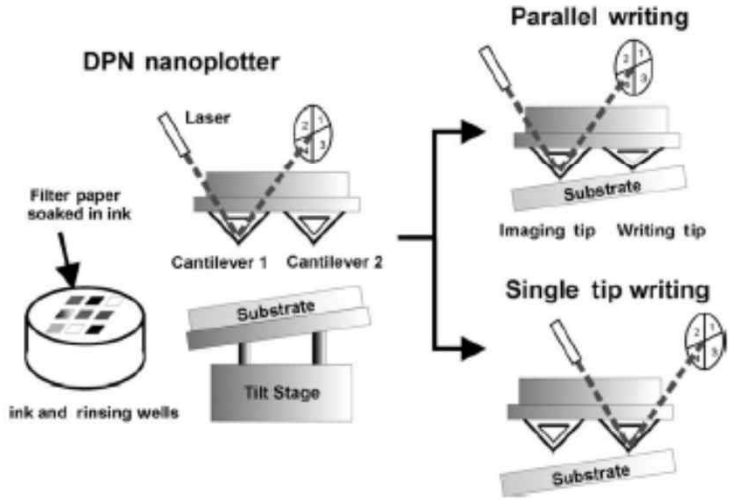
On Oxide surfaces

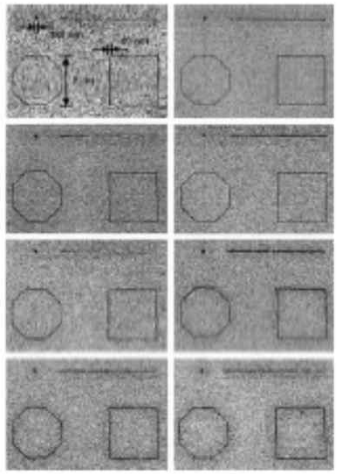
Multiple DPN – 8



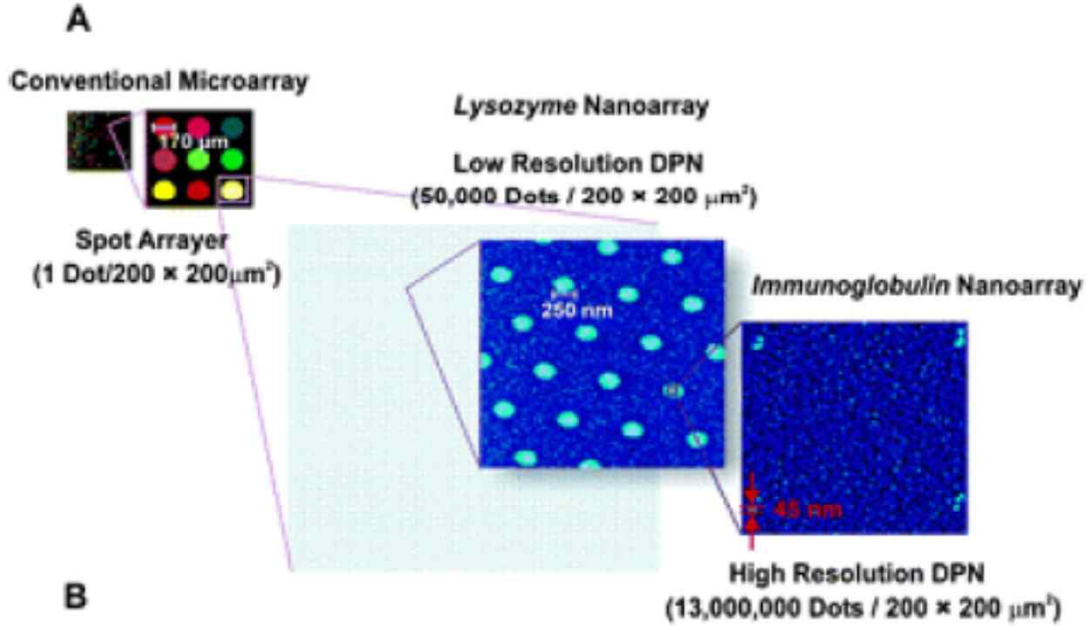


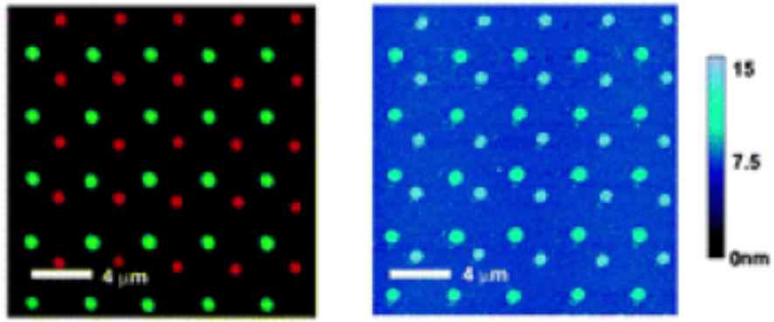






Protein Detection using DPN

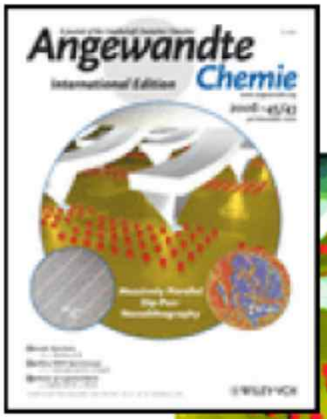


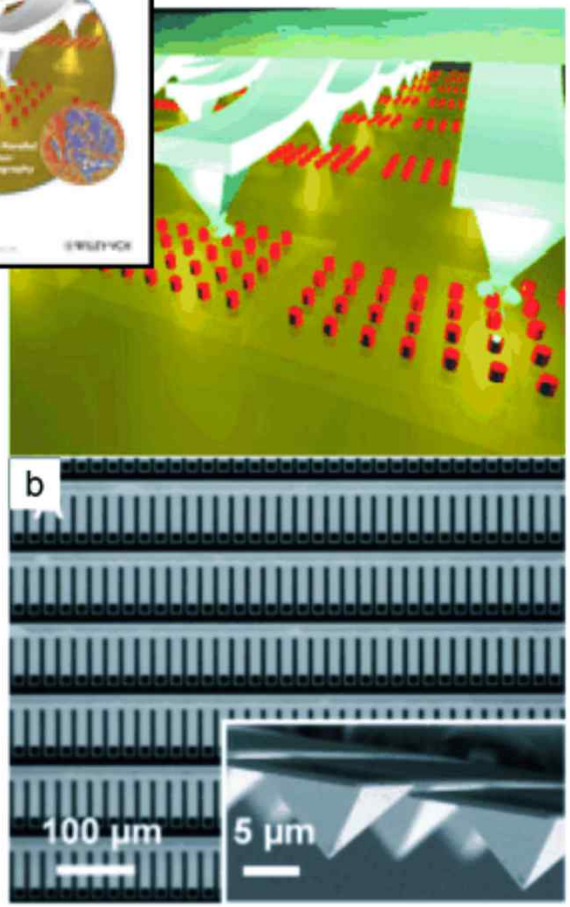


Fluorescence Micrograph:
DNA Hybridized to Pattern

AFM Image of Au NPs
Hybridized to Same Pattern

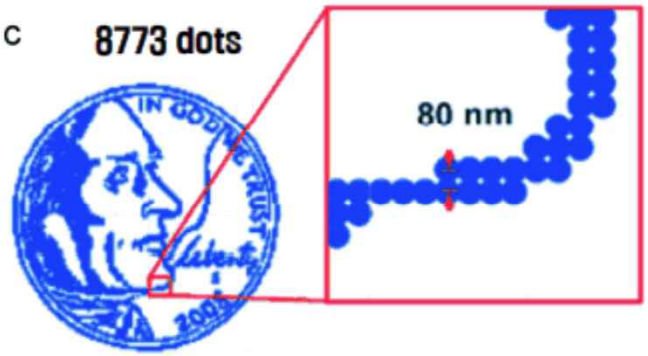
Multiple DPN – 55000

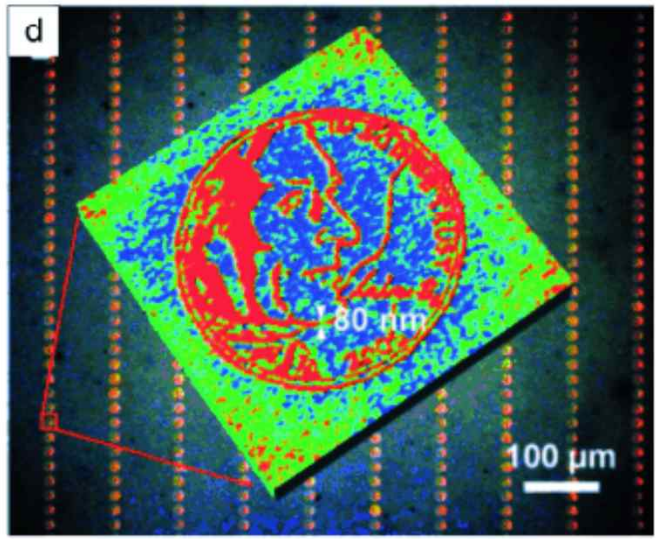




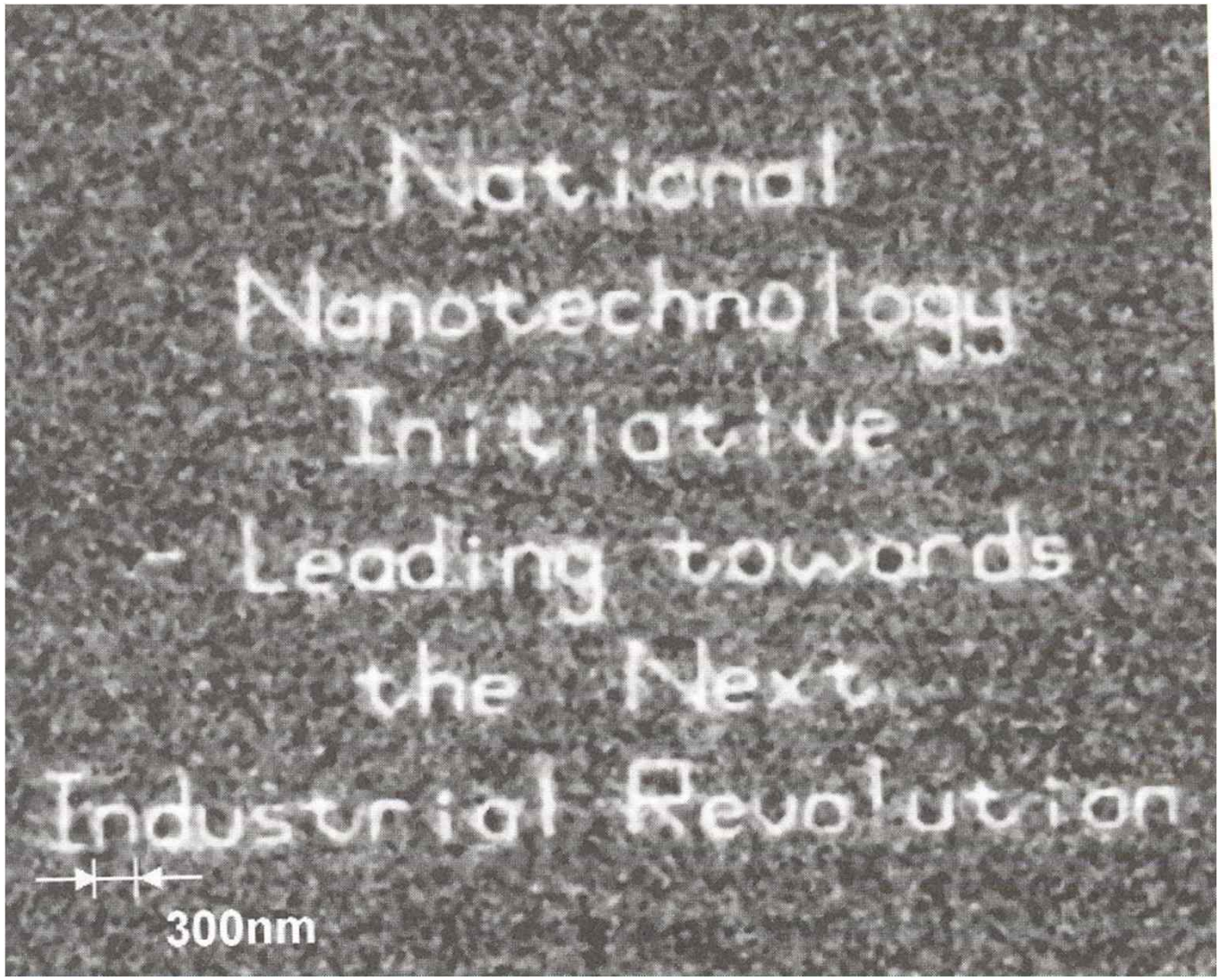
c

8773 dots





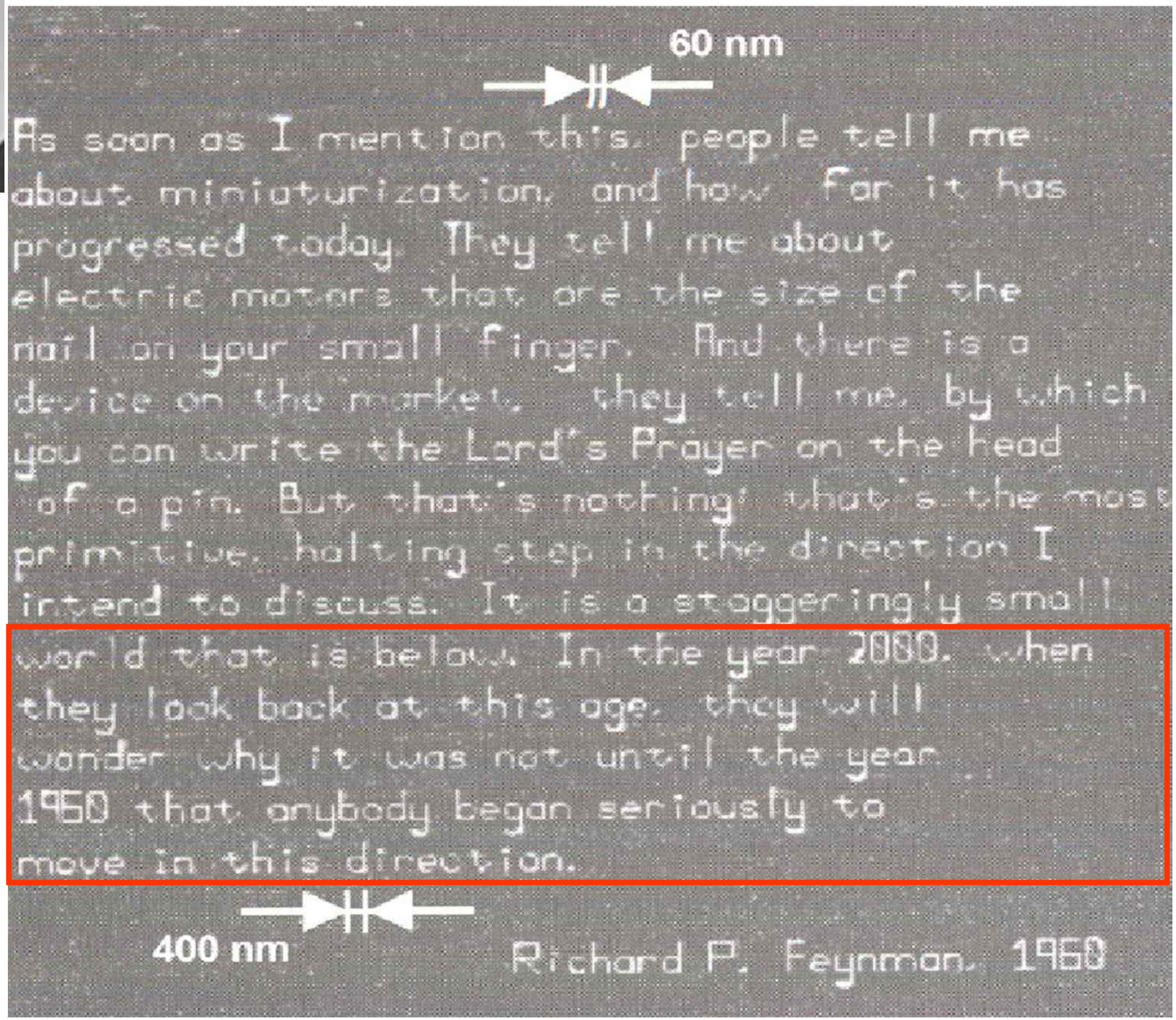
Bill Clinton (2000)



Northwestern University (2000)

Richard P. Feynman (1959)

http://www.youtube.com/watch?v=gFBg0Kj3CQY



Written by Hong & Mirkin (2000)