PaGES7

Planning, Management and Execution of a Scientific Experiment in an international research infrastructure

CERIC

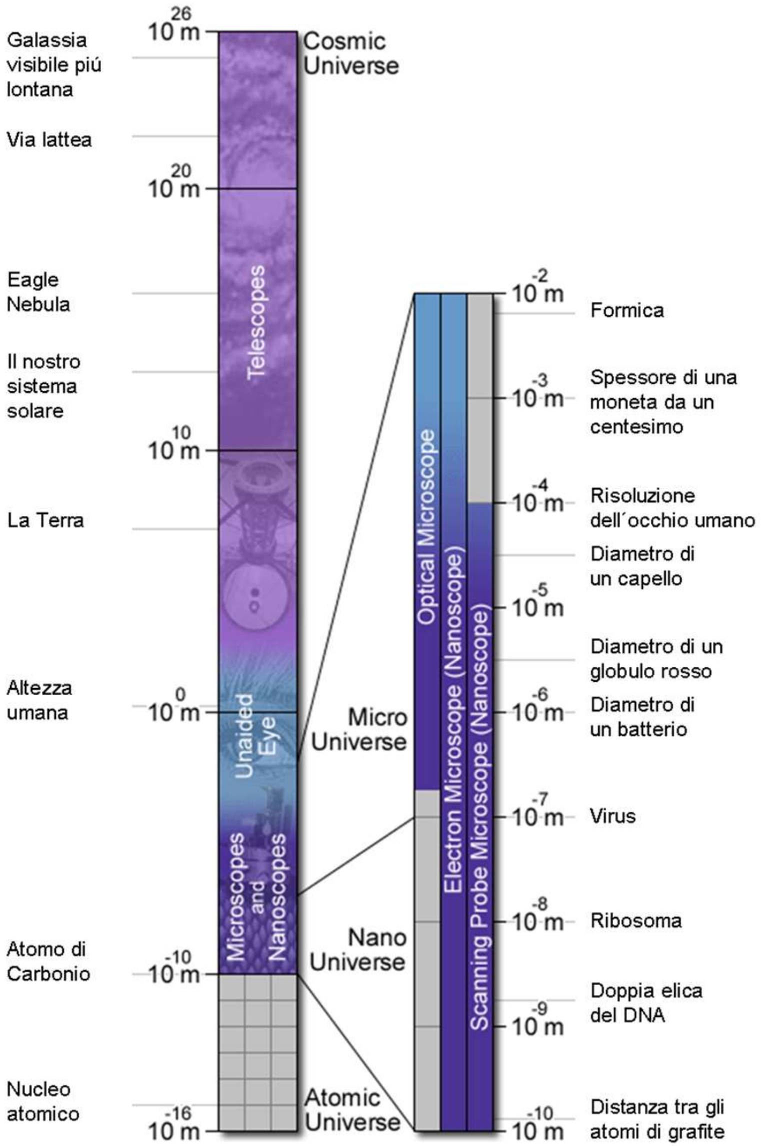
Microfabbricazione e Litografia a raggi x

Come, dove, quando …ma soprattutto… perche'?

Benedetta Marmiroli, Graz University of Technology

TU Graz
Graz University of Technology

Le dimensioni contano



1 μm = 10^{-6} m (un milionesimo di metro)

1 nm = 10^{-9} m (un miliardesimo di metro!)

Capello: diametro ~ 80 μm

Globulo rosso: diametro ~ 8 μm

PM10 : diametro <10 μm

Luce visibile : lunghezza d´onda tra 400 e 700 nm

Doppia elica del DNA: diametro ~ 2 nm.

L´occhio umano riesce a vedere fino a 30-40 μm

Le dimensioni contano: perche'?

L = unitá di lunghezza

Allora l´unitá di superficie diventa

S = L x L

e quella di volume diventa

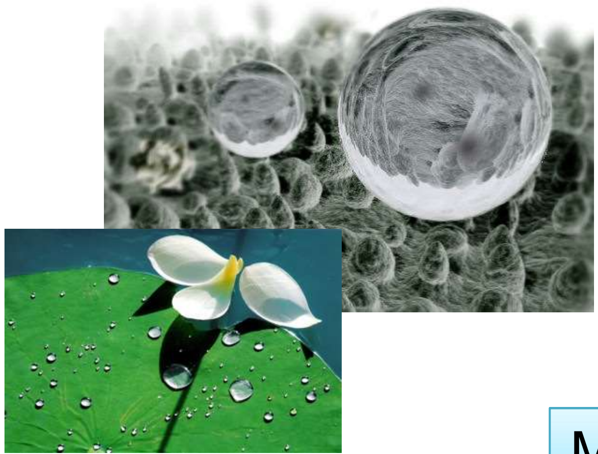
V = L x L x L

L=10	L=1/10
S=100	L= 1/100
V =1000	L=1/1000
Forze di volume >> forze di superficie	Forze di volume << forze di superficie !!

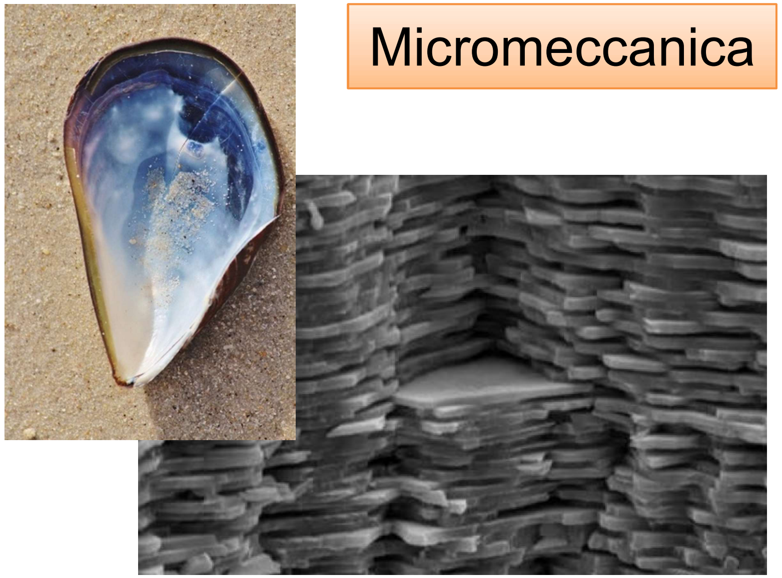
MEMS = Micro Electro Mechanical Systems

Microtecnologie in natura: qualche esempio

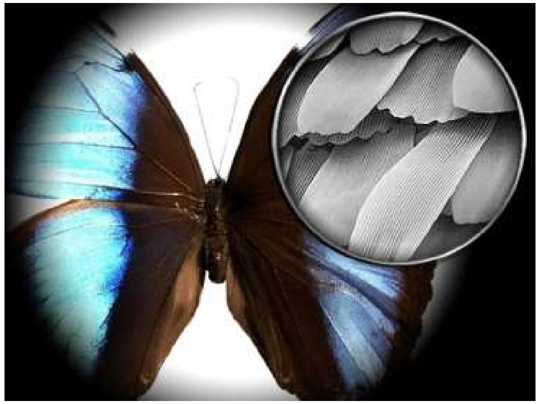
Microfluidica

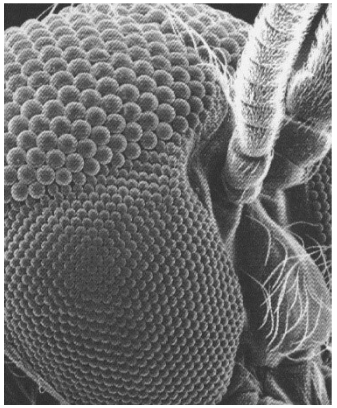


Micromeccanica



Microottica

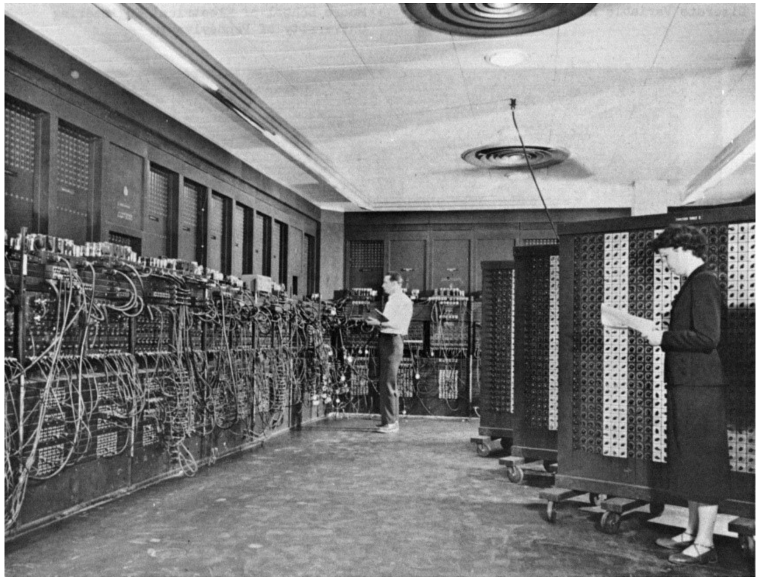




Biomimetica!

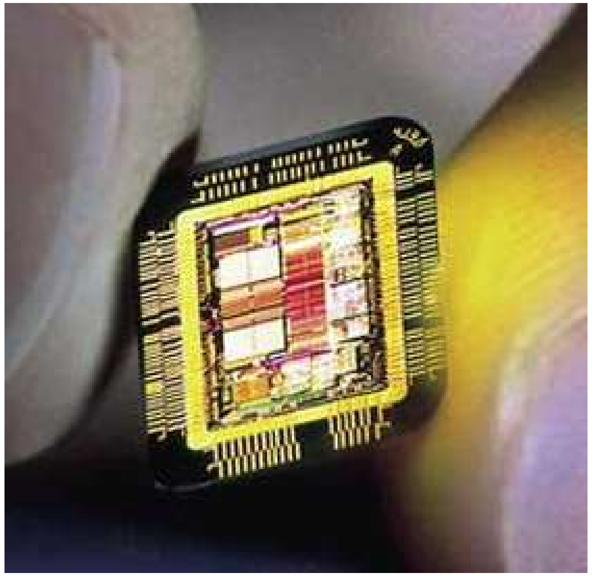
Le origini: la microelettronica

1946



ENIAC *(Electronic Numerical Integrator And Computer = integratore e calcolatore numerico elettronico)*

oggi



Microprocessore (o microchip) contenuto in una tessera bancomat.

Un po' di storia

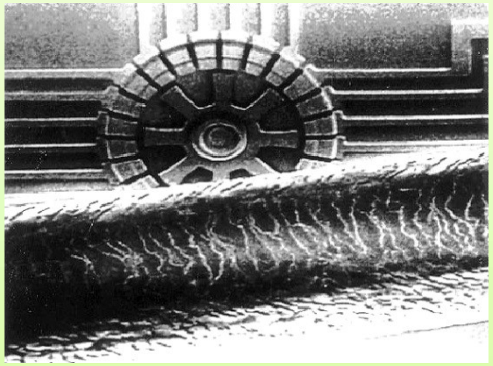
1960
Microsensori

1980
Microattuatori

1988
MEMS

2002
Stampanti a getto d'inchiostro
Sistemi automobilistici
Sistemi biomedici
Telecomunicazioni

Primo micro motore
UC Berkeley



Klaus C. Schadow *Paper presented at the RTO AVT Lecture Series on "MEMS Aerospace Applications",*
held in Montreal, Canada, 3-4 October 2002; Ankara, Turkey, 24-25 February 2003; Brussels, Belgium, 27-28 February 2003; Monterey, CA, USA, 3-4 March 2003, and published in RTO-EN-AVT-105.

Cosa possono fare i MEMS?

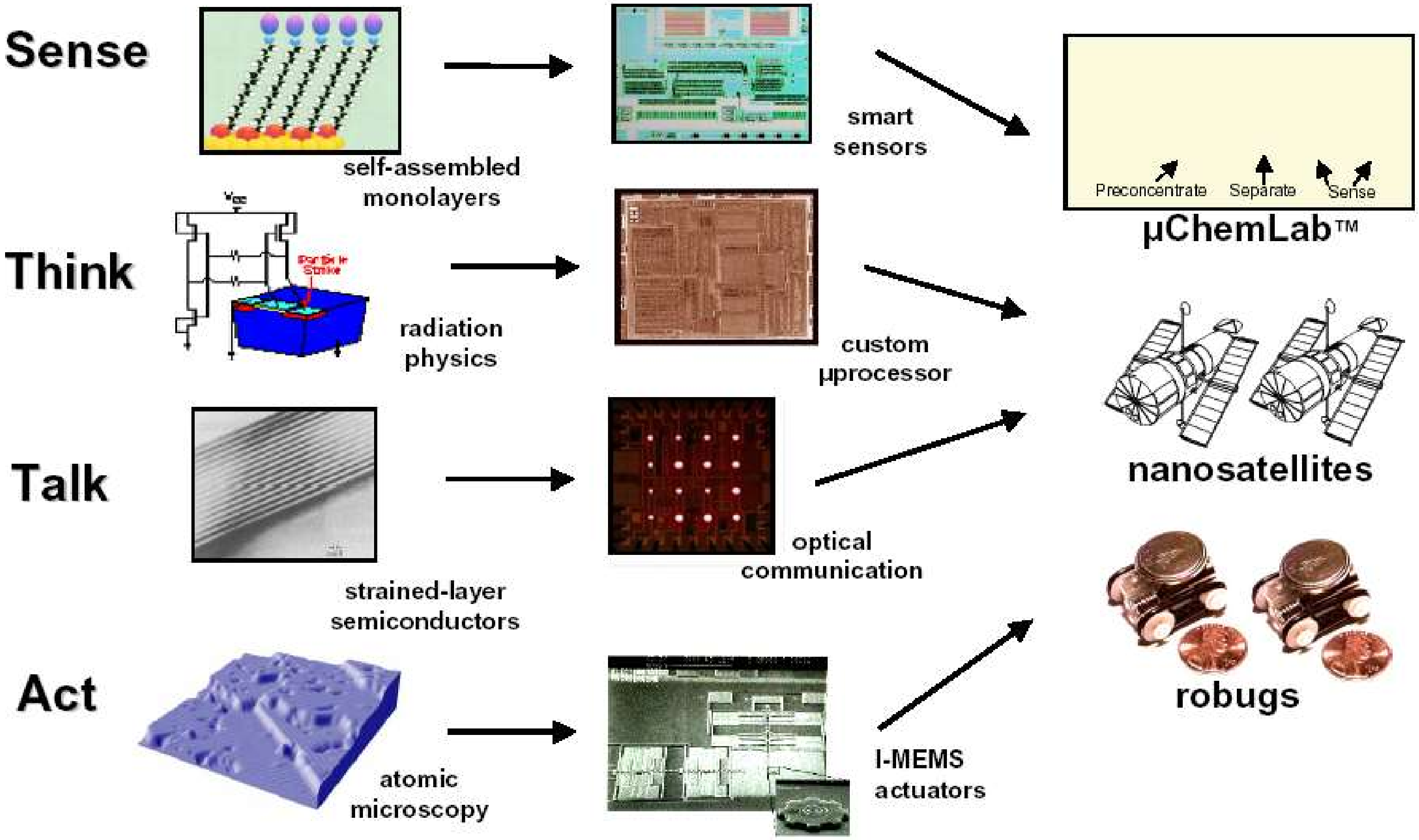


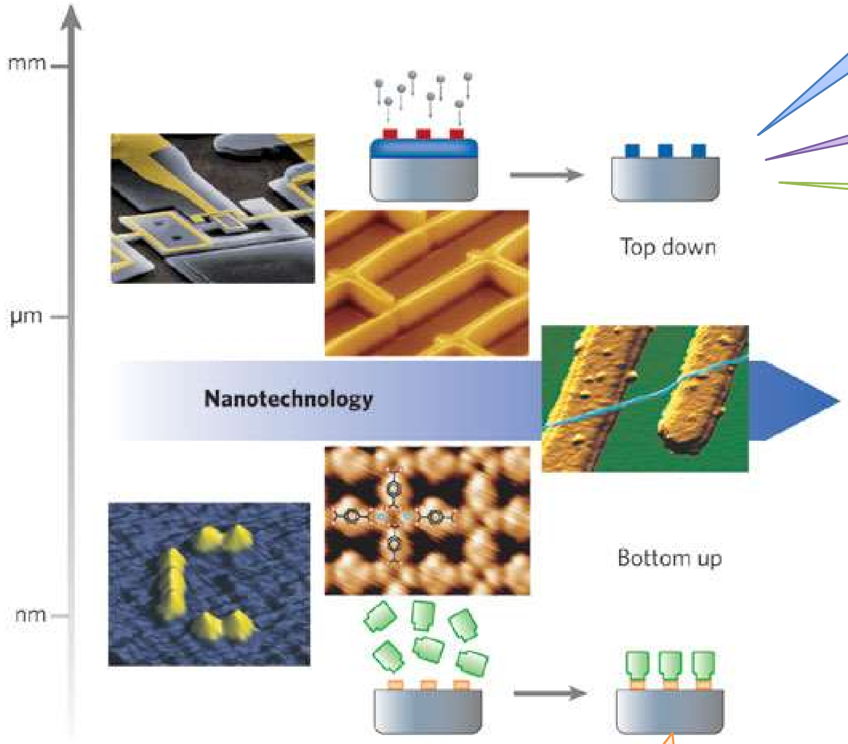
Figure 6.16. The control of mechanical, electrical, optical, and chemical properties at the nanoscale will enable significant improvements in integrated microsystems.

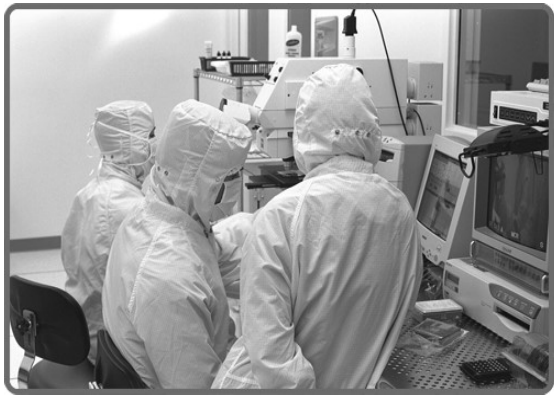
Tecniche di micro/nanofabbricazione

Litografia

Processi additivi

Processi sottrattivi

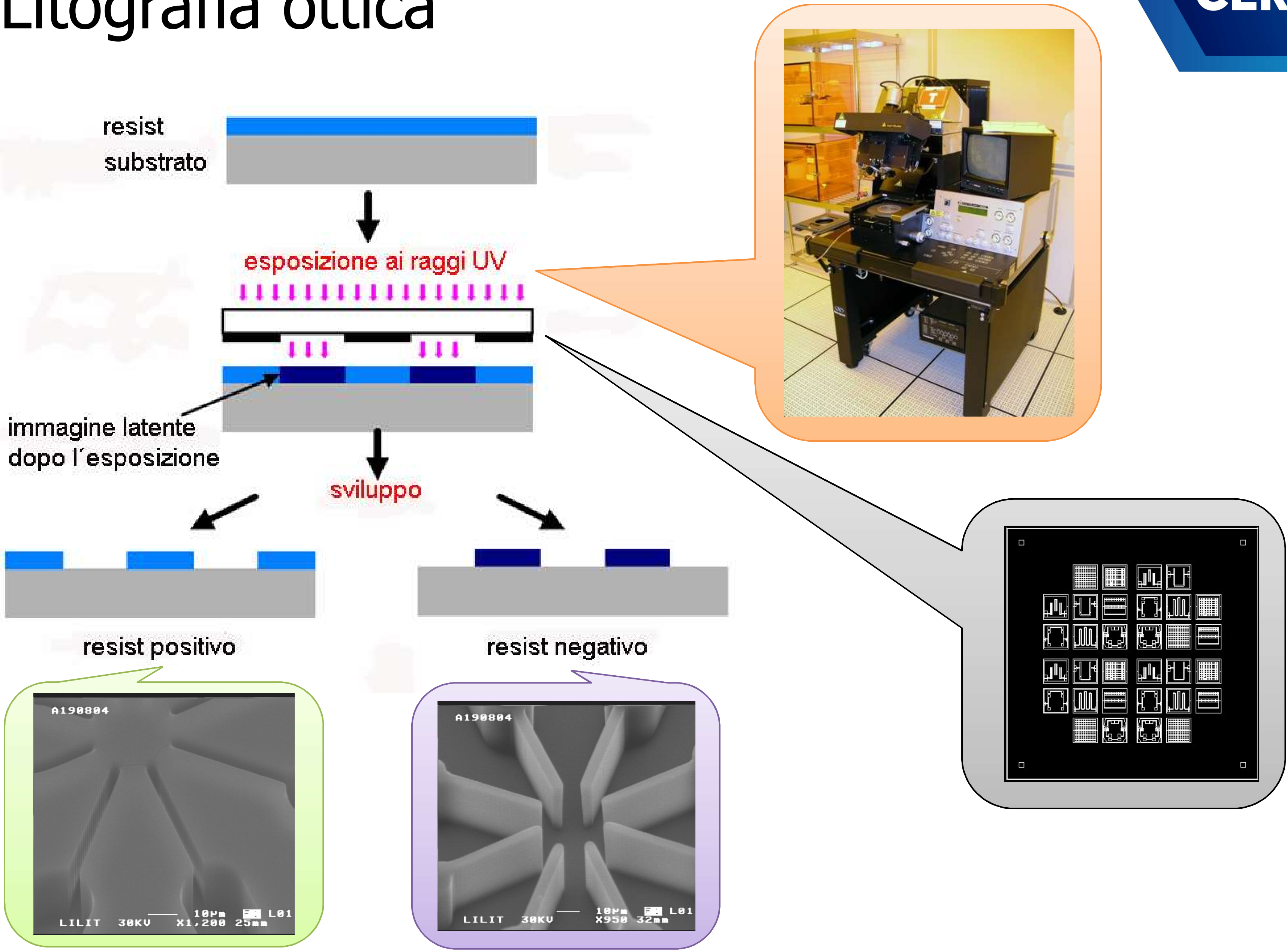




Copyright Udon Mastertech

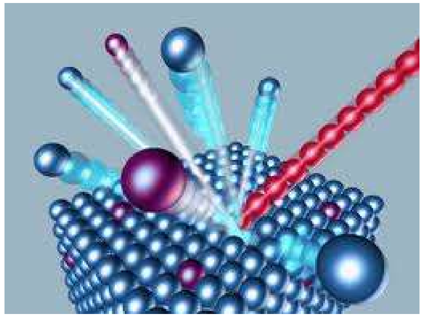
Self- assembly

Litografia ottica



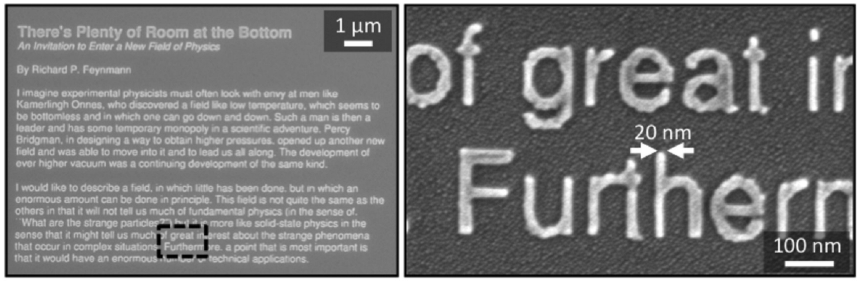
Litografia: altre sorgenti di luce

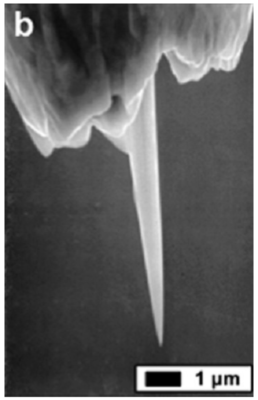
Electron Beam Lithography

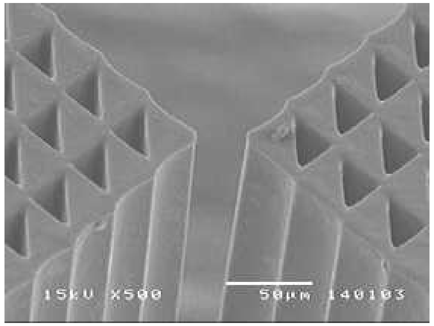


Focused Ion Beam Lithography

X-ray Lithography



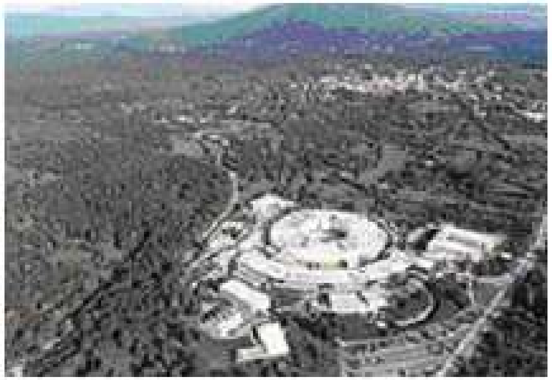




La luce di sincrotrone

Origine

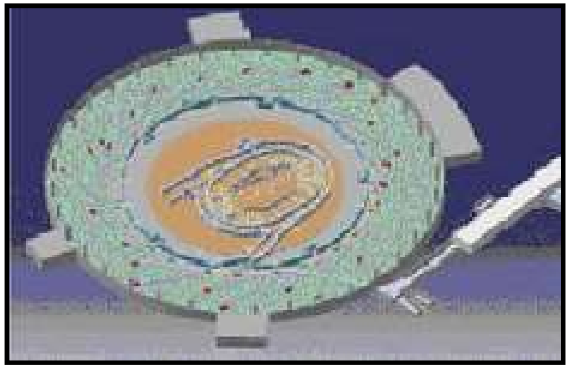
Elettroni relativistici la cui traiettoria viene incurvata da magneti incurvanti (*bending magnets*)



Caratteristiche principali

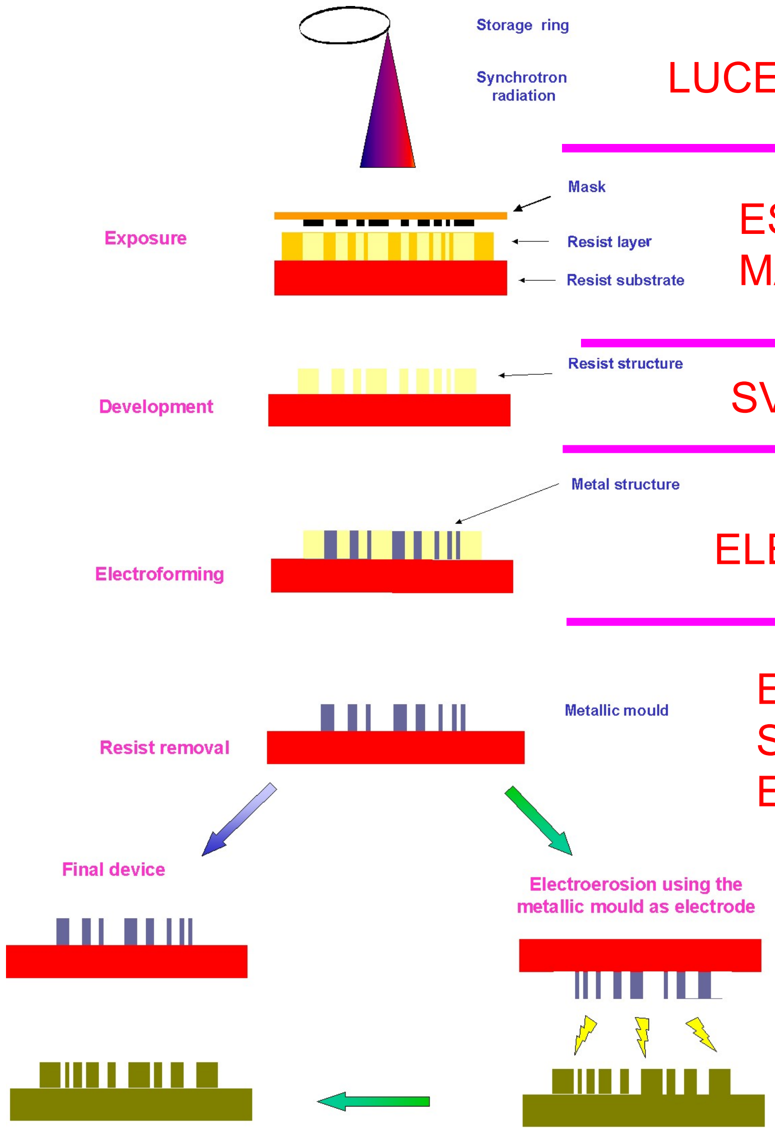
Ampio ventaglio orizzontale, piccolo angolo di emissione

Elevata intensità e grande parallelismo => elevata profondità di penetrazione, ottima accuratezza, alto rapporto di forma



Litografia a raggi x e tecnica LIGA

CERIC



LUCE DI SINCROTRONE

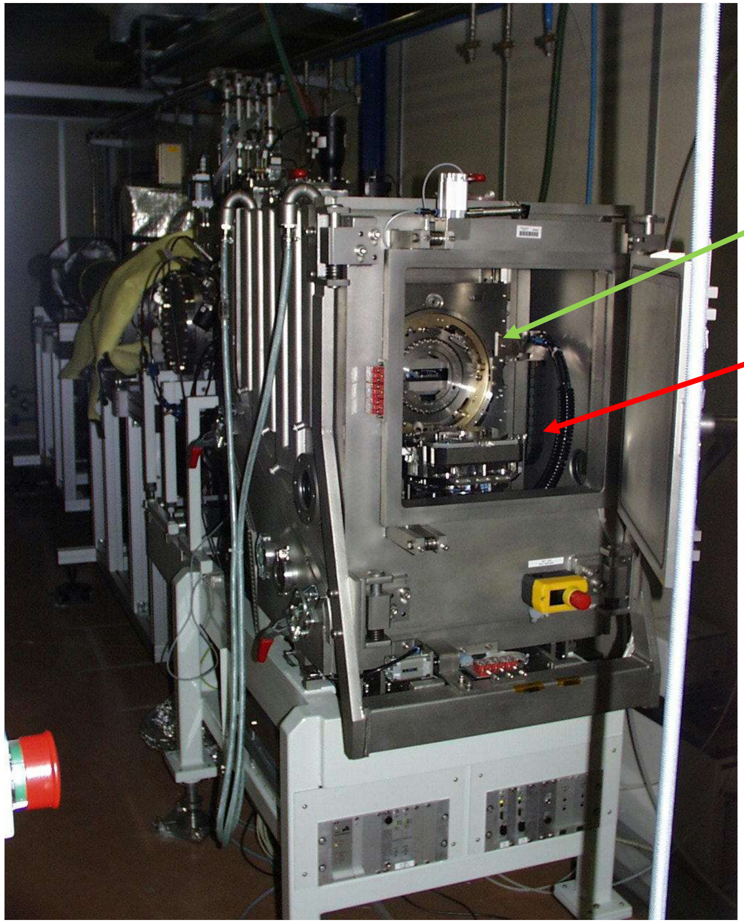
ESPOSIZIONE CON MASCHERA RAGGI X

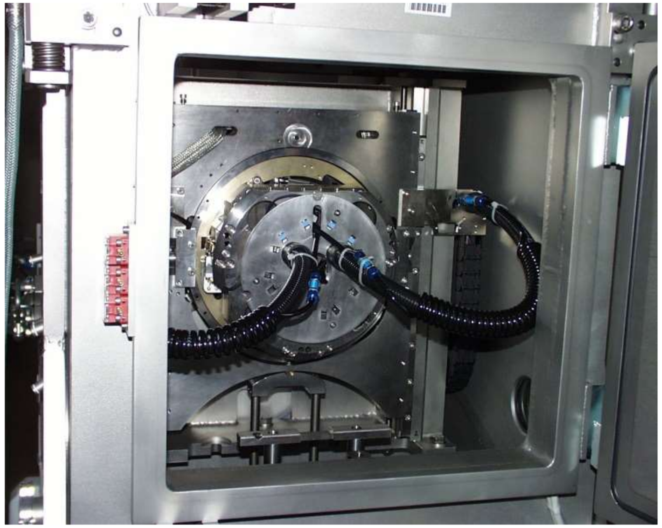
SVILUPPO DEL RESIST

ELETTRODEPOSIZIONE

ELETTROEROSIONE
STAMPAGGIO
ECC ECC

Lo scanner a raggi x

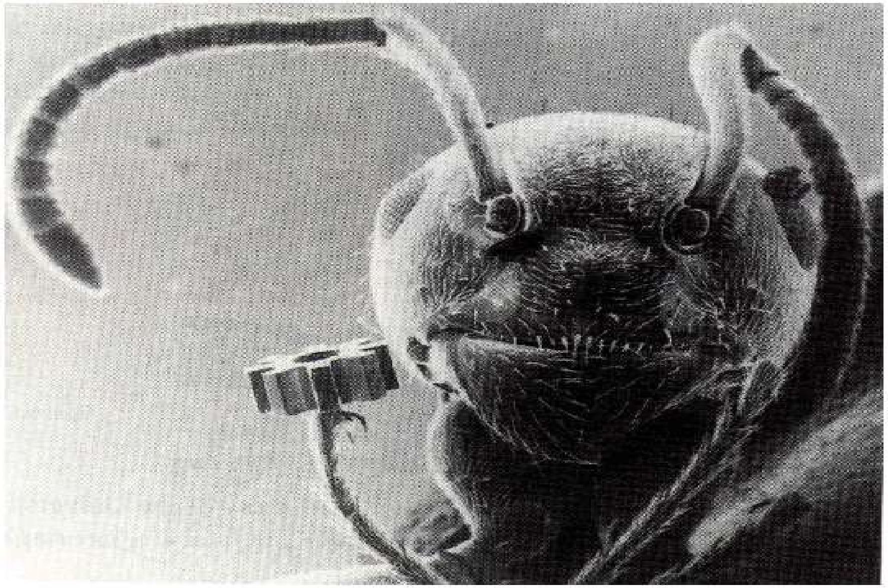




Cosa si puo' fare?

Litografia a raggi X tradizionale:

Fabbricazione di microdispositivi

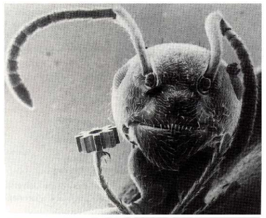


Sviluppo di nanomateriali funzionali per dispositivi con prestazioni migliorate

Techniche Top down + bottom up

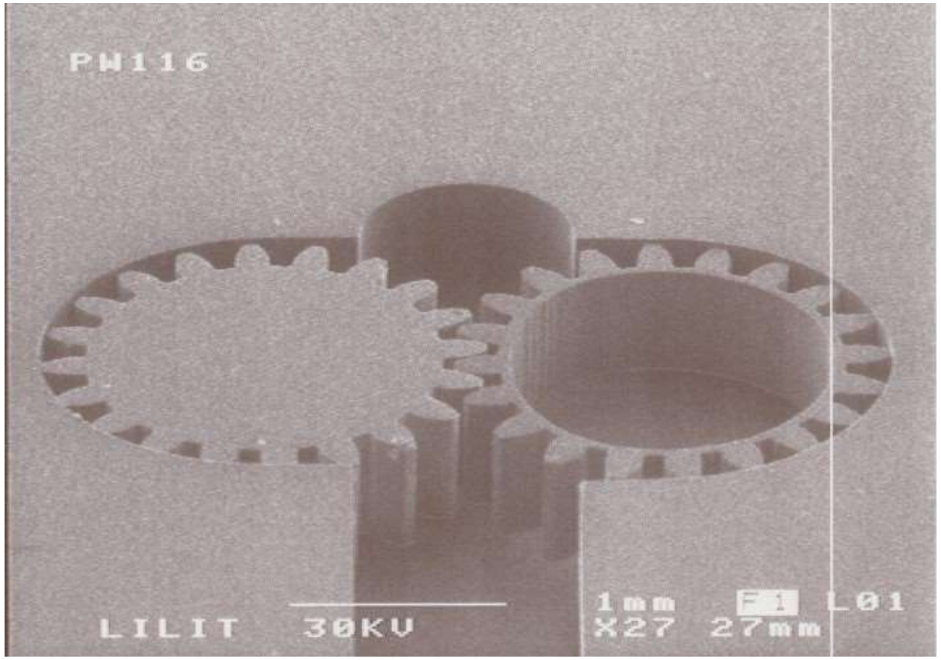
Sintesi e lavorazione di nuovi materiali mediante irraggiamento controllato

Fabbricazione di microdispositivi

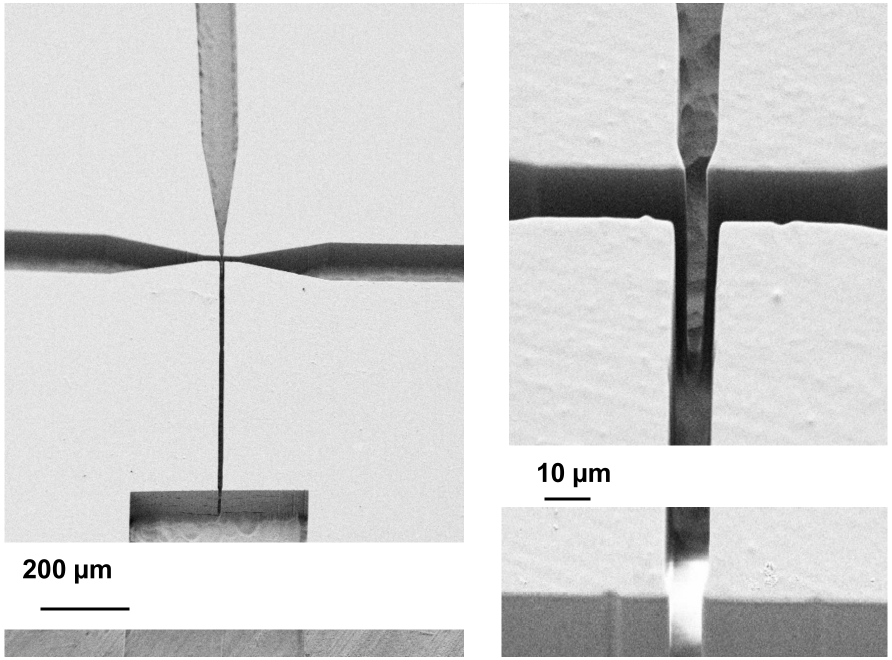


DXRL: irraggiamento coi raggi x

Micropompa a ingranaggi a trascinamento magnetico

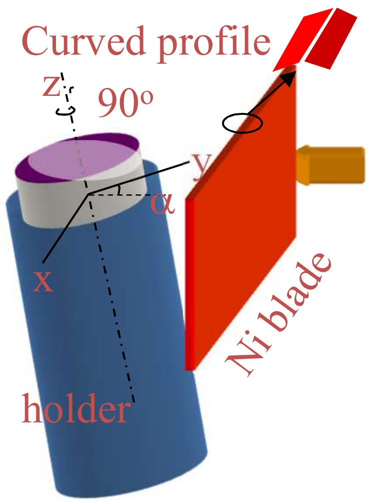


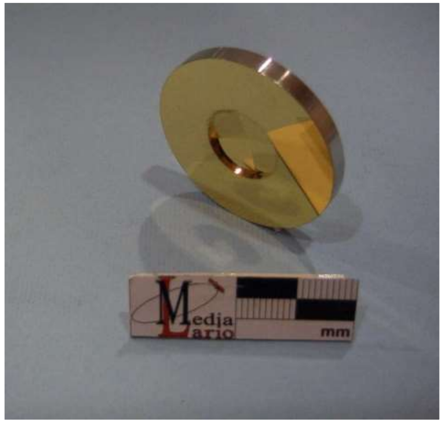
Micromiscelatore

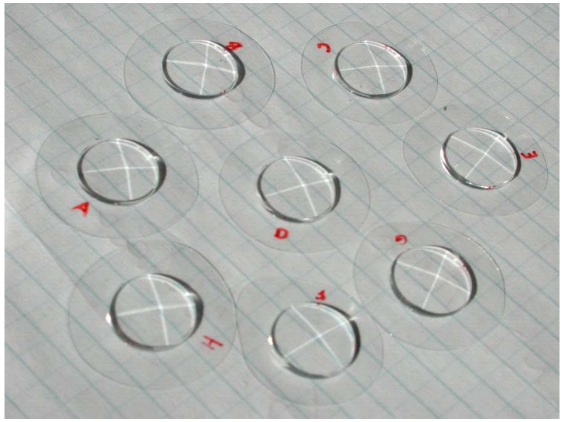


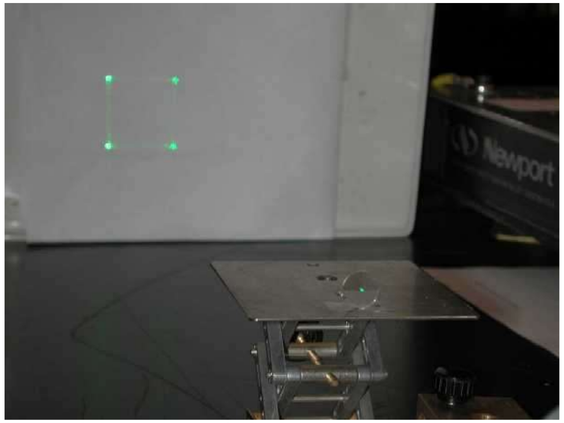
LIGA: irraggiamento + elettrodeposizione + stampaggio

Sensori di fronte d'onda piramidali per ottiche adattive







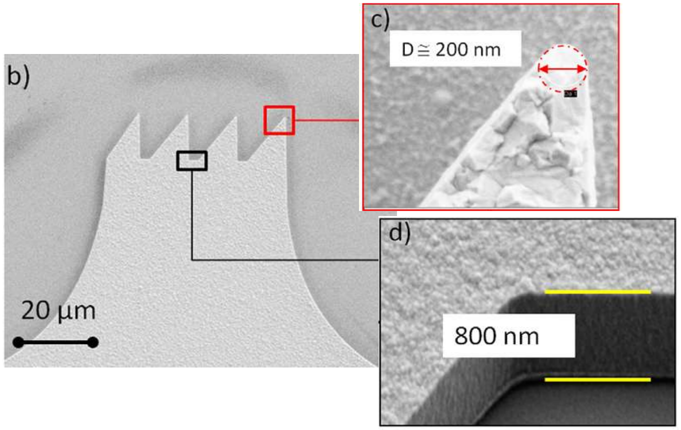


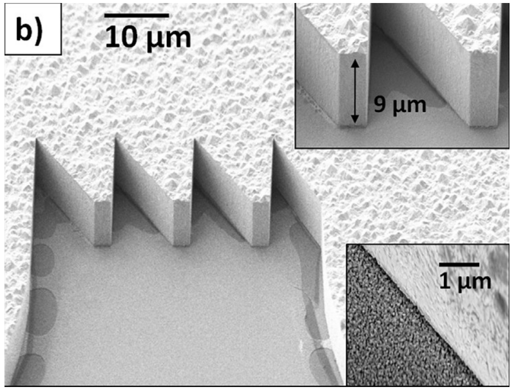
M. Ghigo et al., *Proceedings of SPIE* Vol. 4839, p 259-265 (2002)

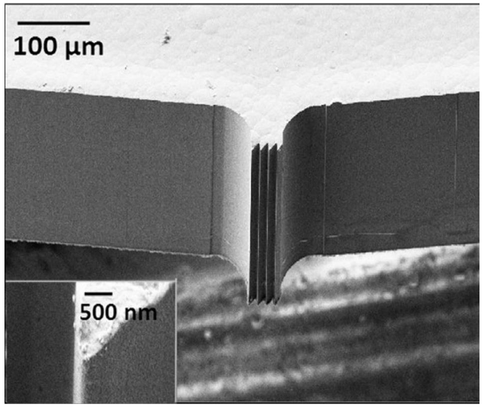
M. Ghigo et al., *Proceeding of the Conference: Adaptive Optics for Extremely Large Telescopes*, Venice, Italy, 7-10 May (2001)

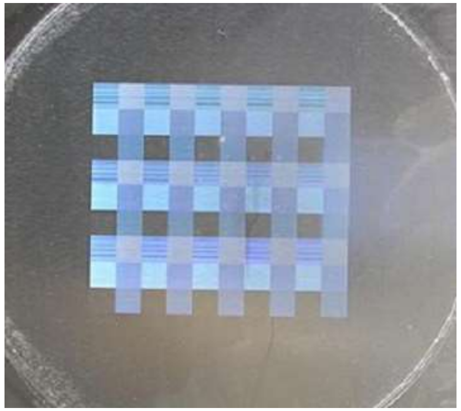
LIGA: irraggiamento + elettrodeposizione + hot embossing

Grigile a punta affilata per rivestimenti antiriflesso









T. Mäkelä et al, Microelectronic Engineering, 98, 180-183 (2012)

G. Grenci et al., Sensors and Actuators A 205, 111– 118 (2014)

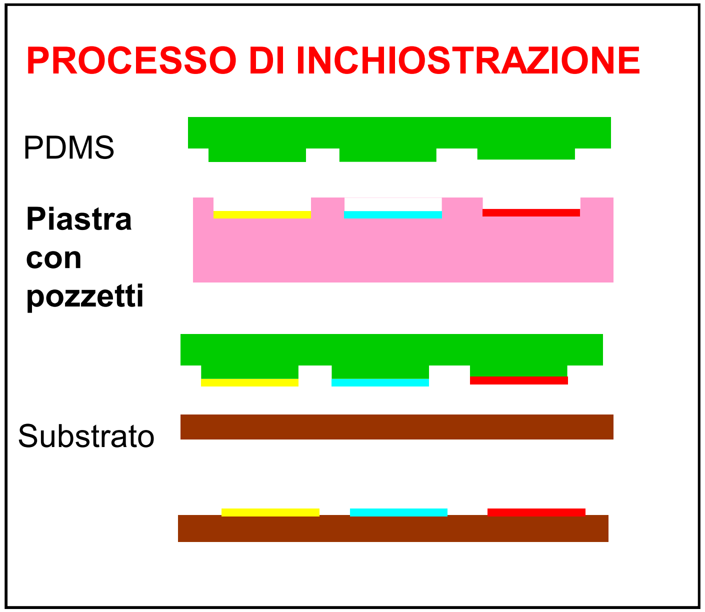
LIGA: irraggiamento + elettrodeposizione + elettroerosione

Rotori di microturbine per applicazioni aerospaziali

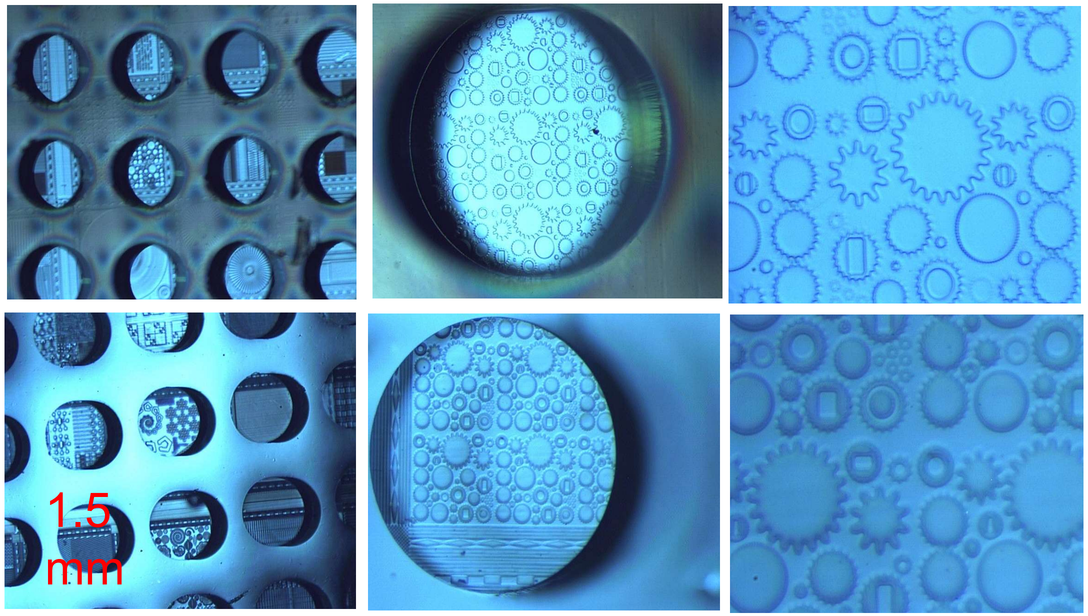
B. Marmiroli et al, Proceedings of CANEUS 2004-Monterey (California), 1-5/11/04, AIAA 2004-6710, pp 42-48 (2004)

Colata su uno stampo con una struttura gerarchica

Dispositivo per lo stampaggio di diverse funzionalizzazioni chimiche



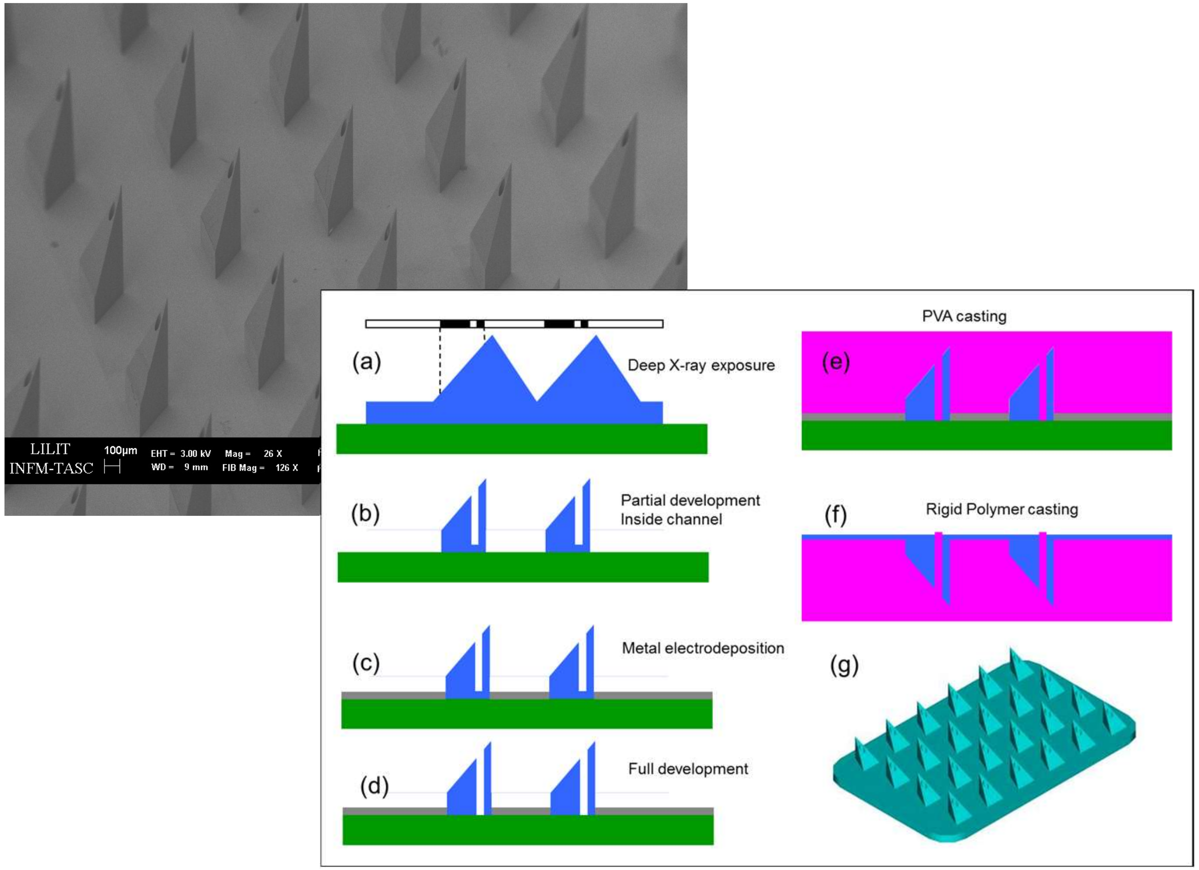
Stampo di SU8

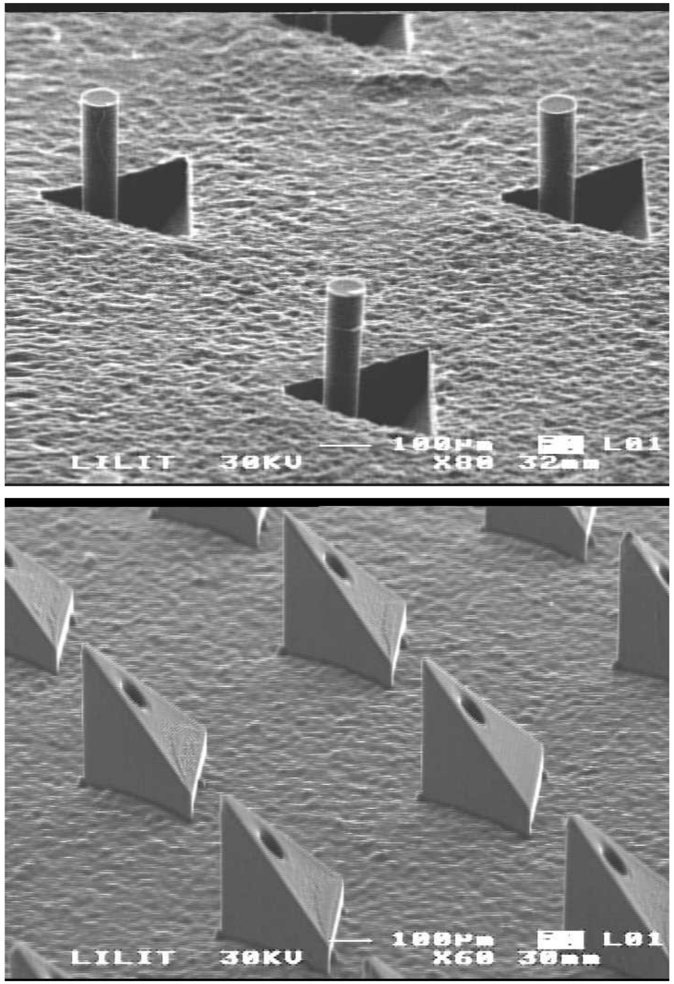


Replica di PDMS

Colata su uno stampo con pareti inclinate e strutture sporgenti

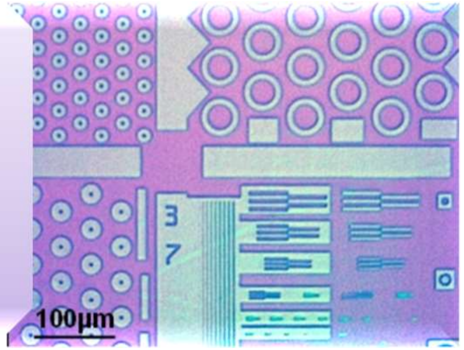
Sistema di rilascio controllato di farmaci basato su microaghi





F. Pérennès et al, J. Micromech. Microeng., 16, 473-479 (2006).

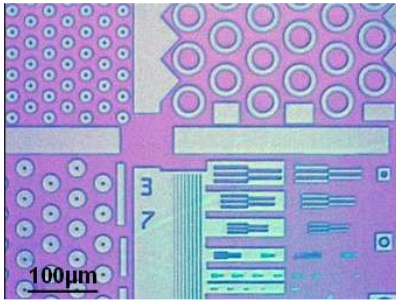
Sintesi e lavorazione di materiali mediante irraggiamento controllato



Patterning (modellazione) di film sottili

Film mesoporosi: materiali che contengono pori di diametro tra 2 e 50nm. Sono ottenuti tramite assemblaggio di surfattanti che formano micelle e danno forma al componente inorganico durante la sintesi

SiO2



sviluppo: etilen glicole + etanolo

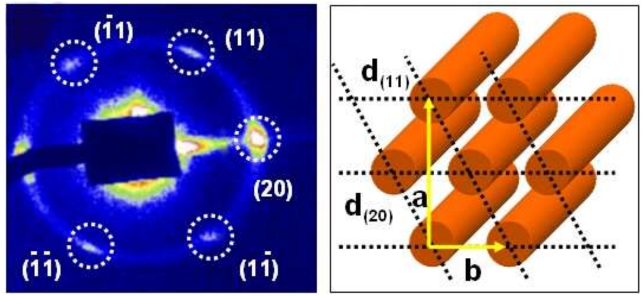
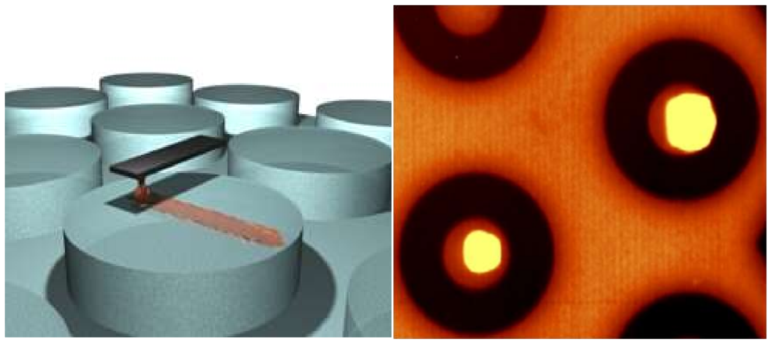


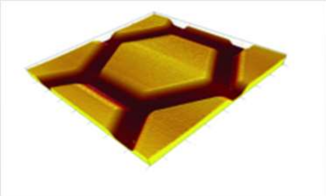
Immagine GISAXS : simmetria p6m

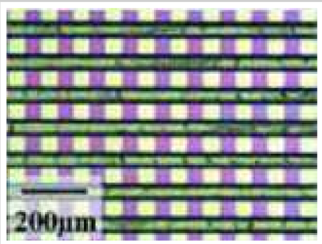


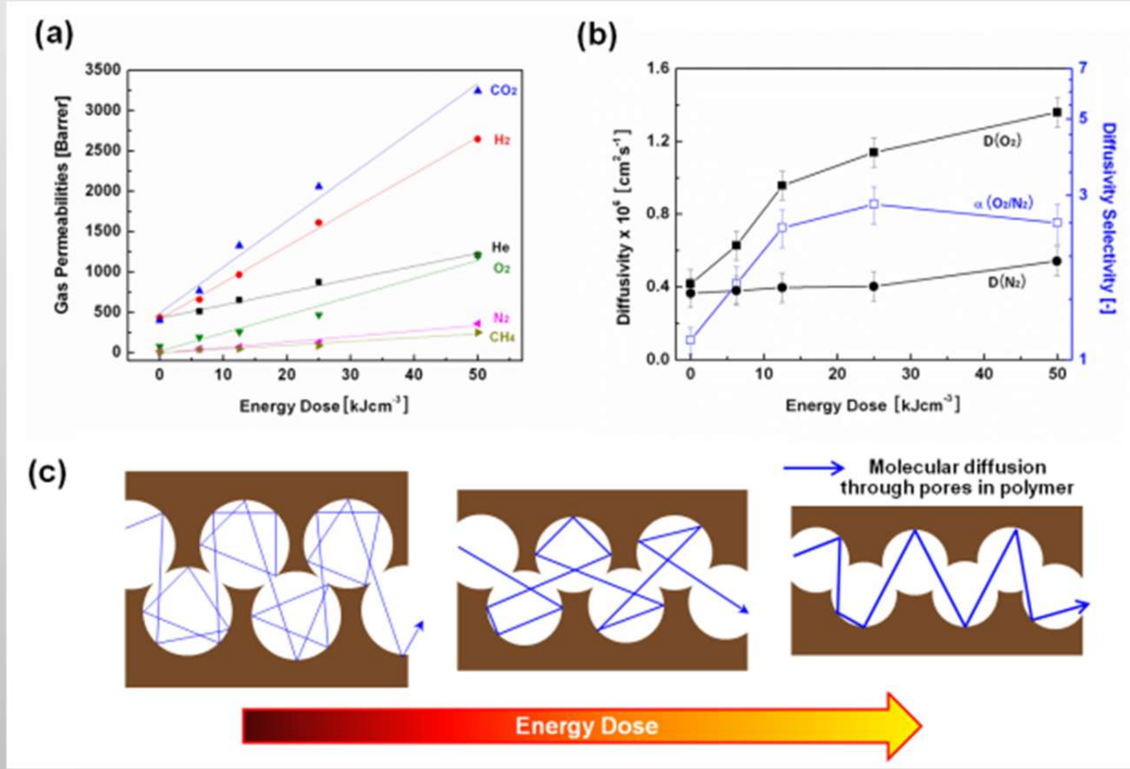
Funzionalizzaione con rodamina 6G con il sistema di dip-pen

Verso la nanofluidica

Patterning e selezione della permeabilitá in polimeri microporosi







S. H. Han et al., Small, 9, 13, 2277 (2013)


There is plenty of room at the bottom
R. Feynmann