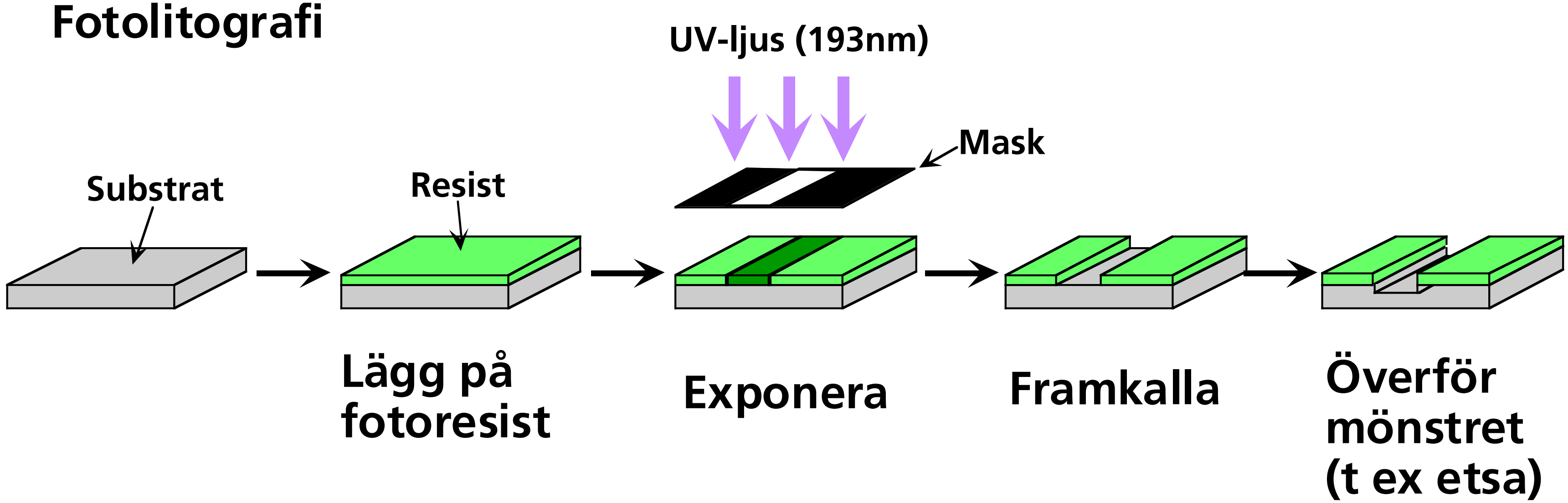
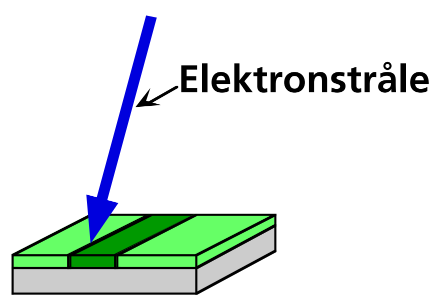
Tillverkning 1: Litografi

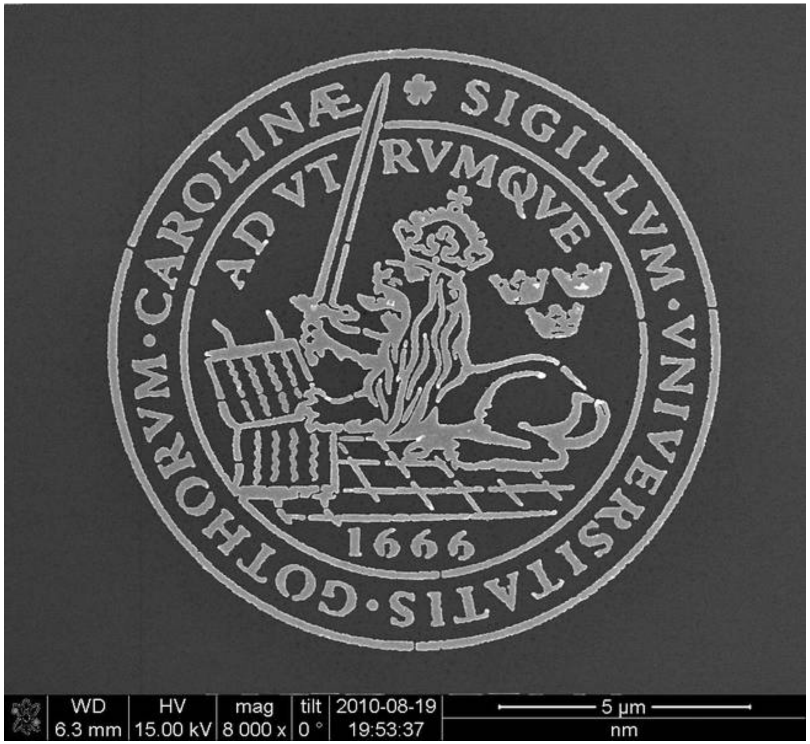
Fotolitografi



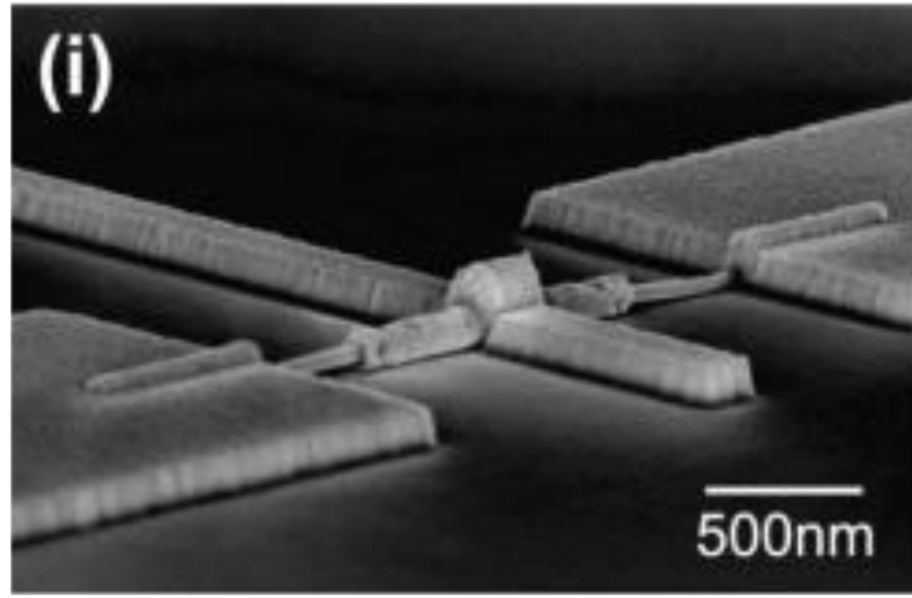
Elektronstråle-litografi



Litografi

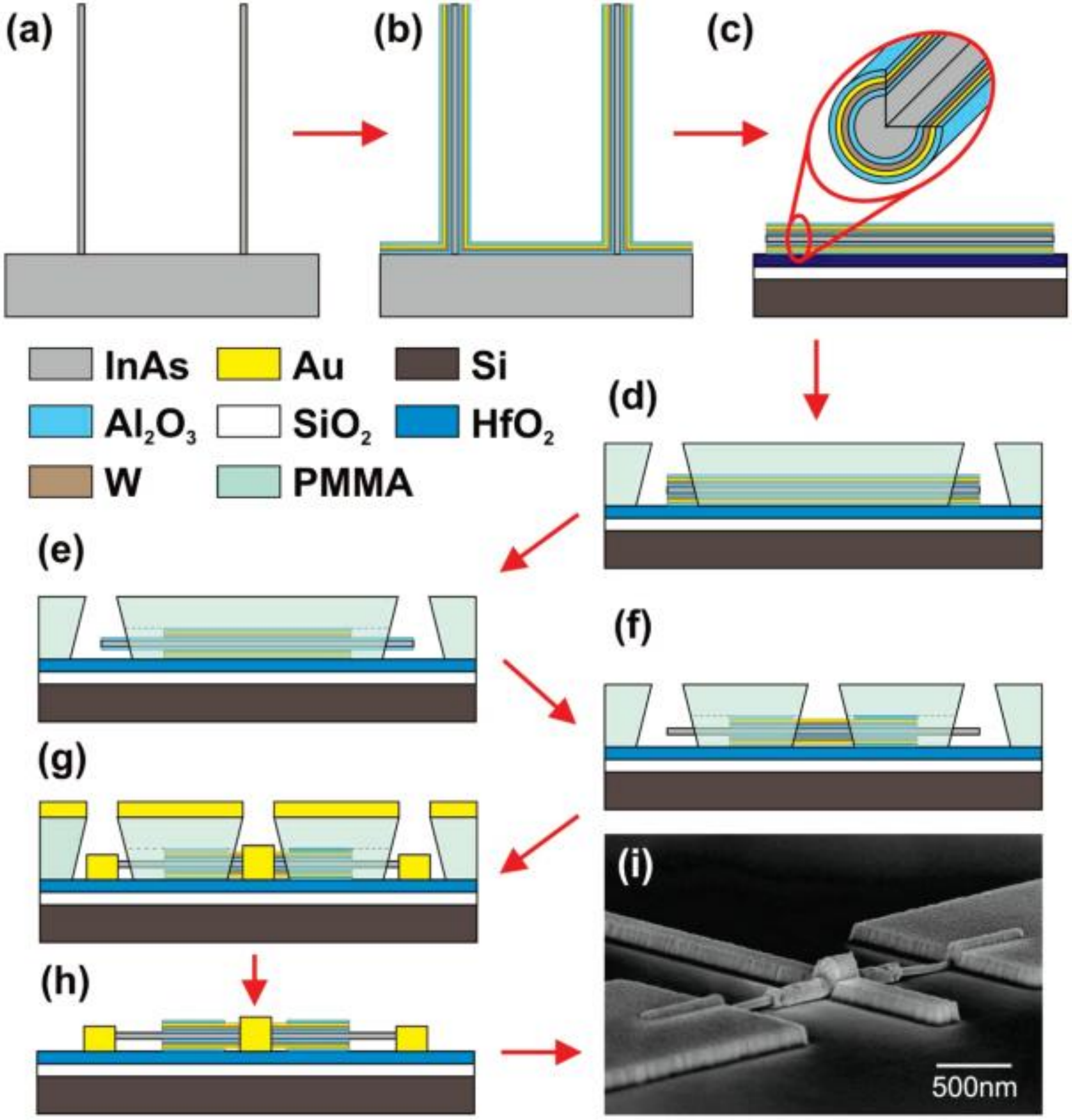


SIGILLVM · VNIVERSITATIS · GOTHORVM · CAROLINÆ
AD VTRVMQVE
1666
WD
6.3 mm
HV
15.00 kV
mag
8 000 x
tilt
0 °
2010-08-19
19:53:37
5 µm
nm

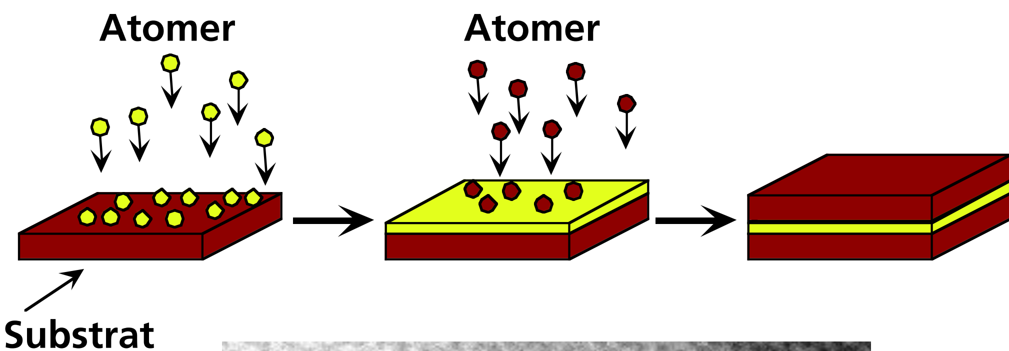


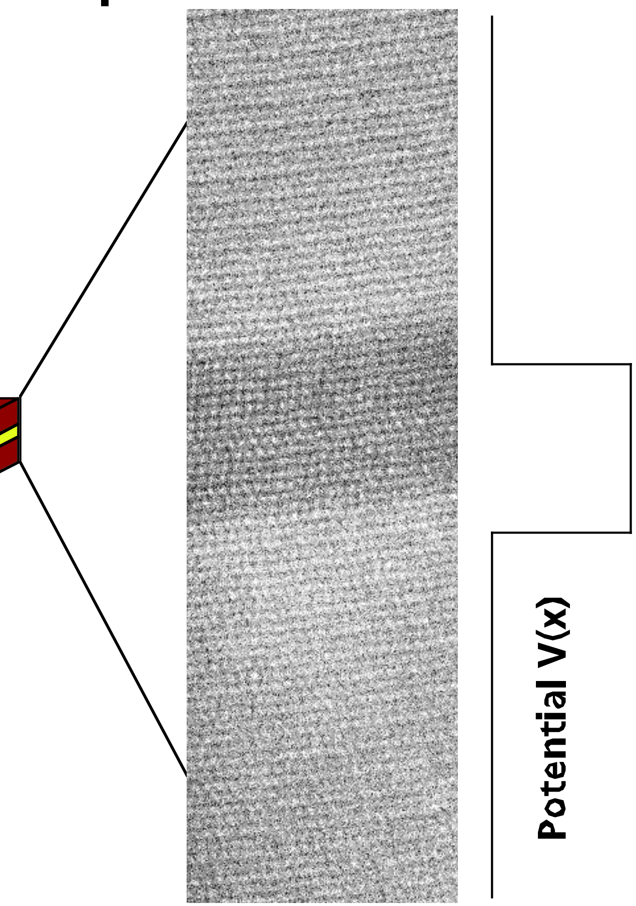
(i)
500nm

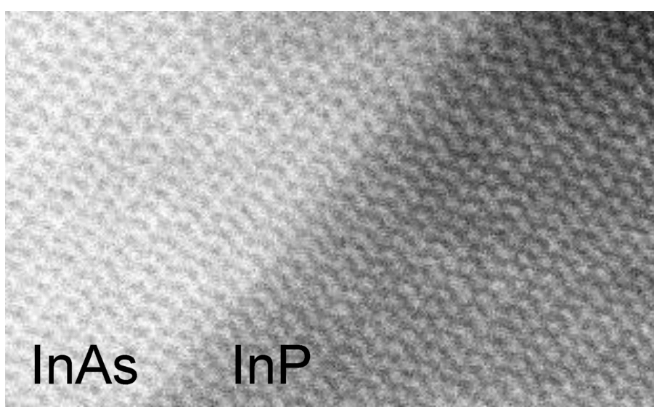
Flera steg för att göra en komponent



Tillverkning 2:
Epitaxi – att bygga vidare på kristaller



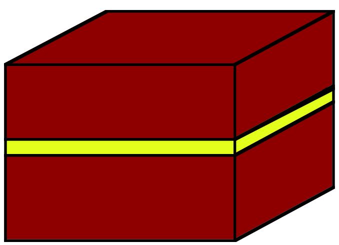




Perfekt övergång mellan materialen
med kontroll på atomnivå.

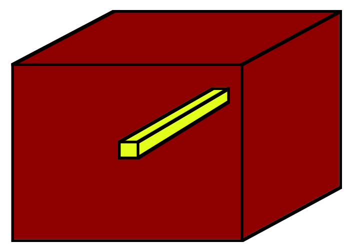
Kvantstrukturer

2D



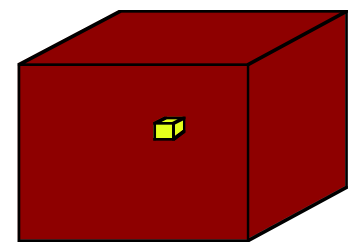
Kvantbrunn

1D



Kvanttråd

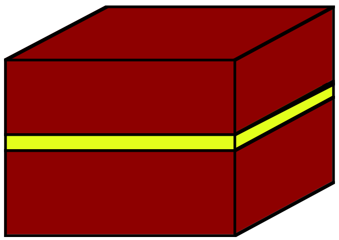
0D



Kvantprick

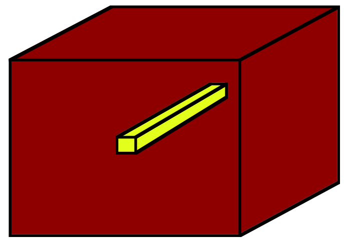
Kvantstrukturer

2D



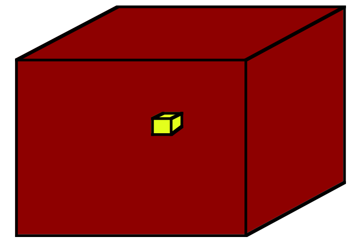
Kvantbrunn

1D



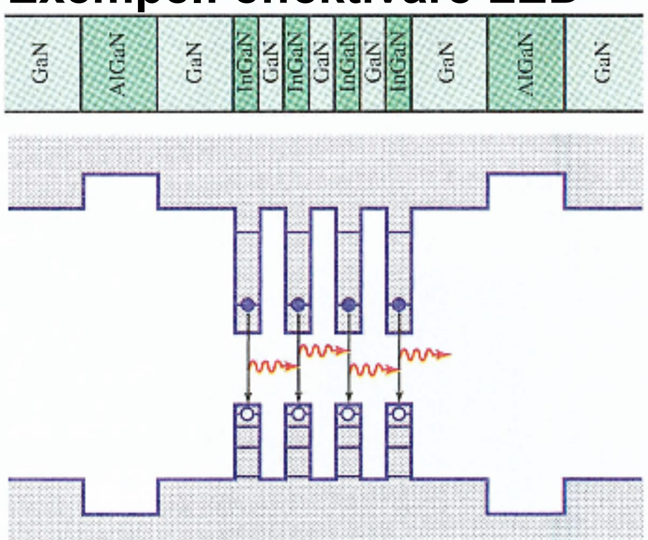
Kvanttråd

0D

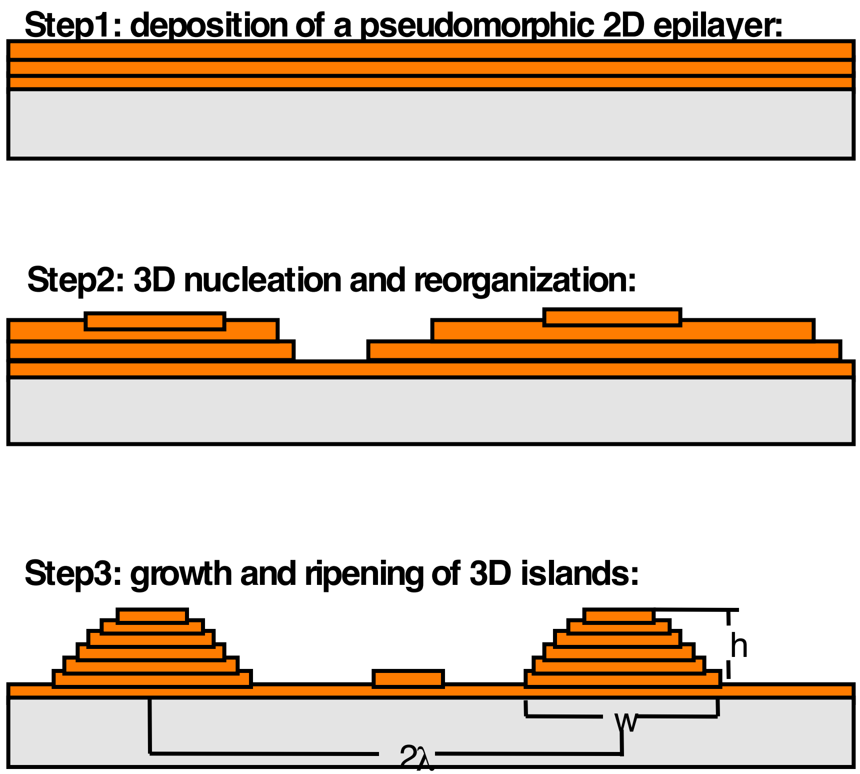


Kvantprick

Exempel: effektivare LED



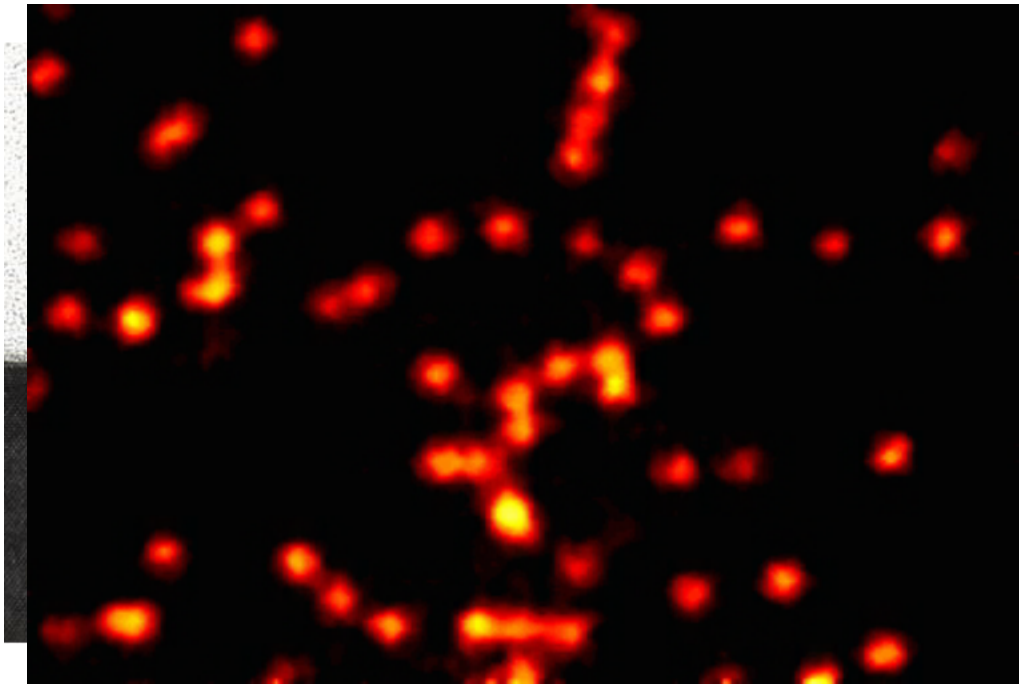
Självordnande kvantprickar



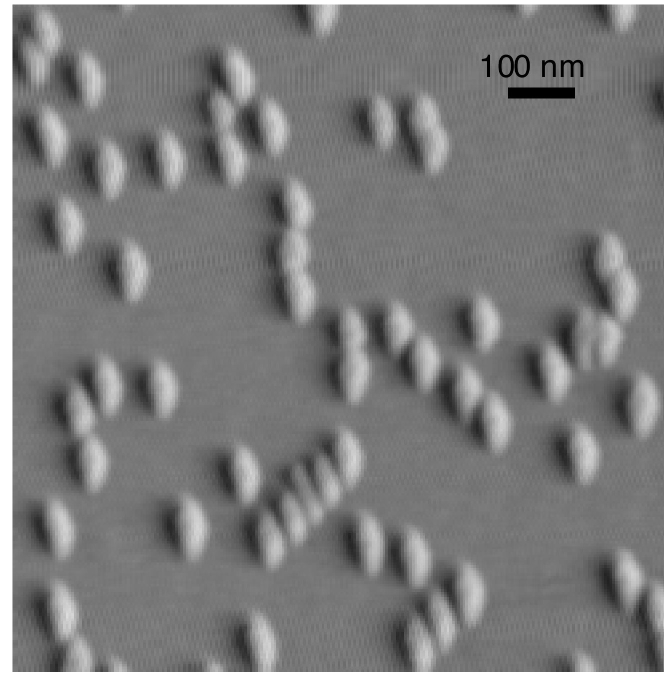
Dessa öar kan användas som kvantprickar

Materialsystem: InP/GaInP, InAs/InP, InAs/GaAs, Ge/Si

InP kvantprick på GaInP



TEM-bild
Luminiscens-bild



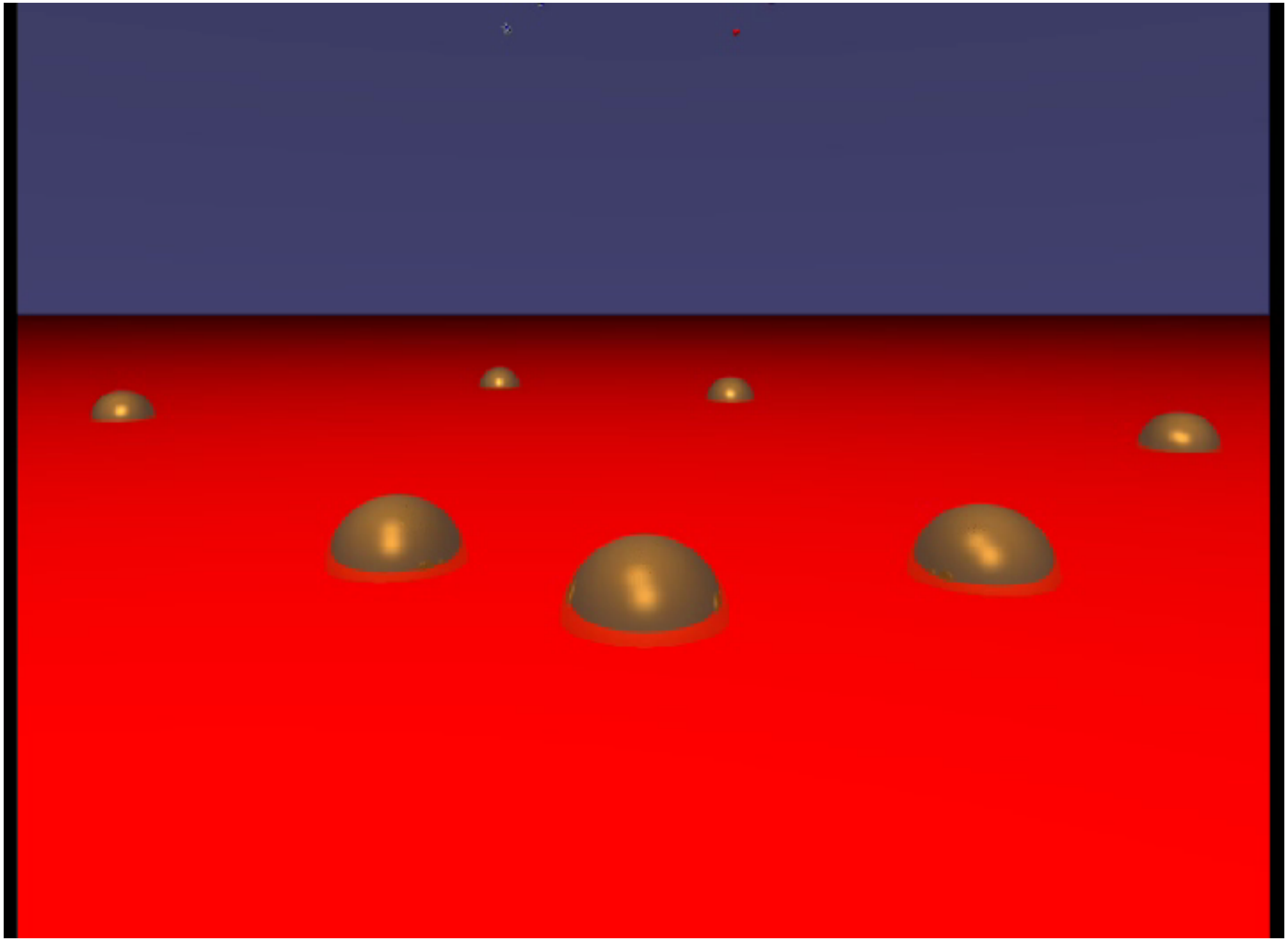
AFM-bild

3D island **InP**/GaInP
MOVPE 580 °C
(K. Georgsson et al.
APL 67 (1995) 2981)

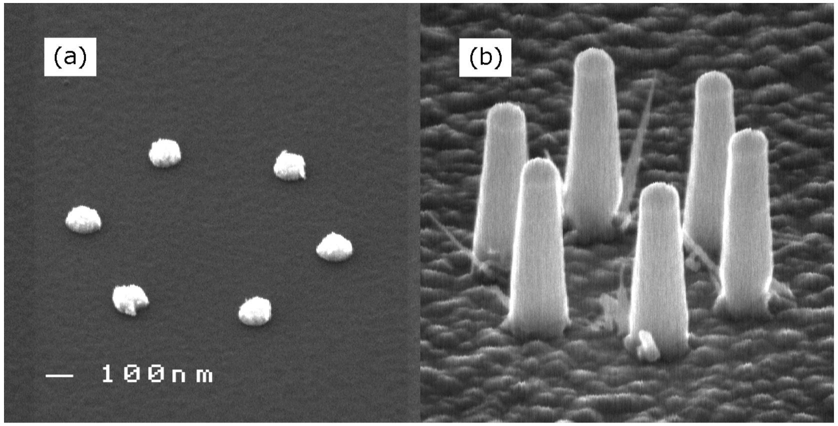
Top-down eller bottom-up?

Vår specialitet: Nanotrådar

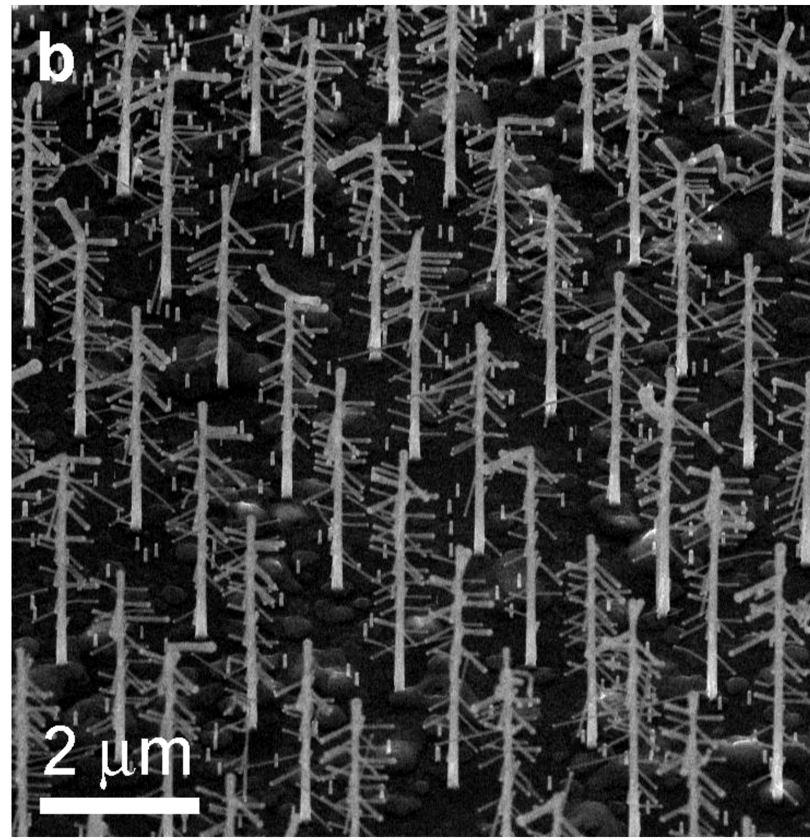
10 nm - 100 nm i diameter, några μm långa



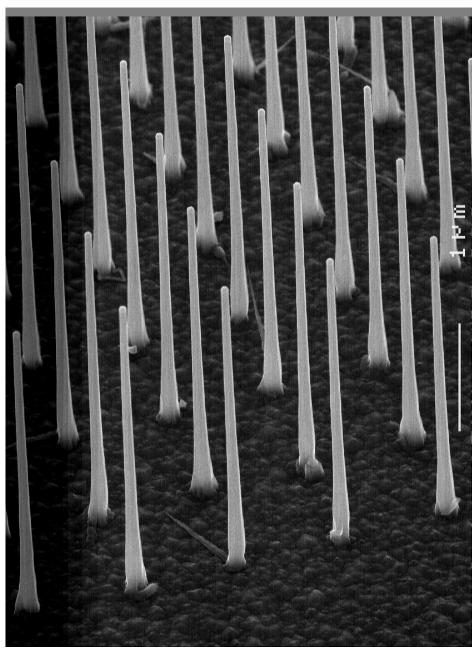
Nanotrådar



Ordnade rader av GaP nanoträd

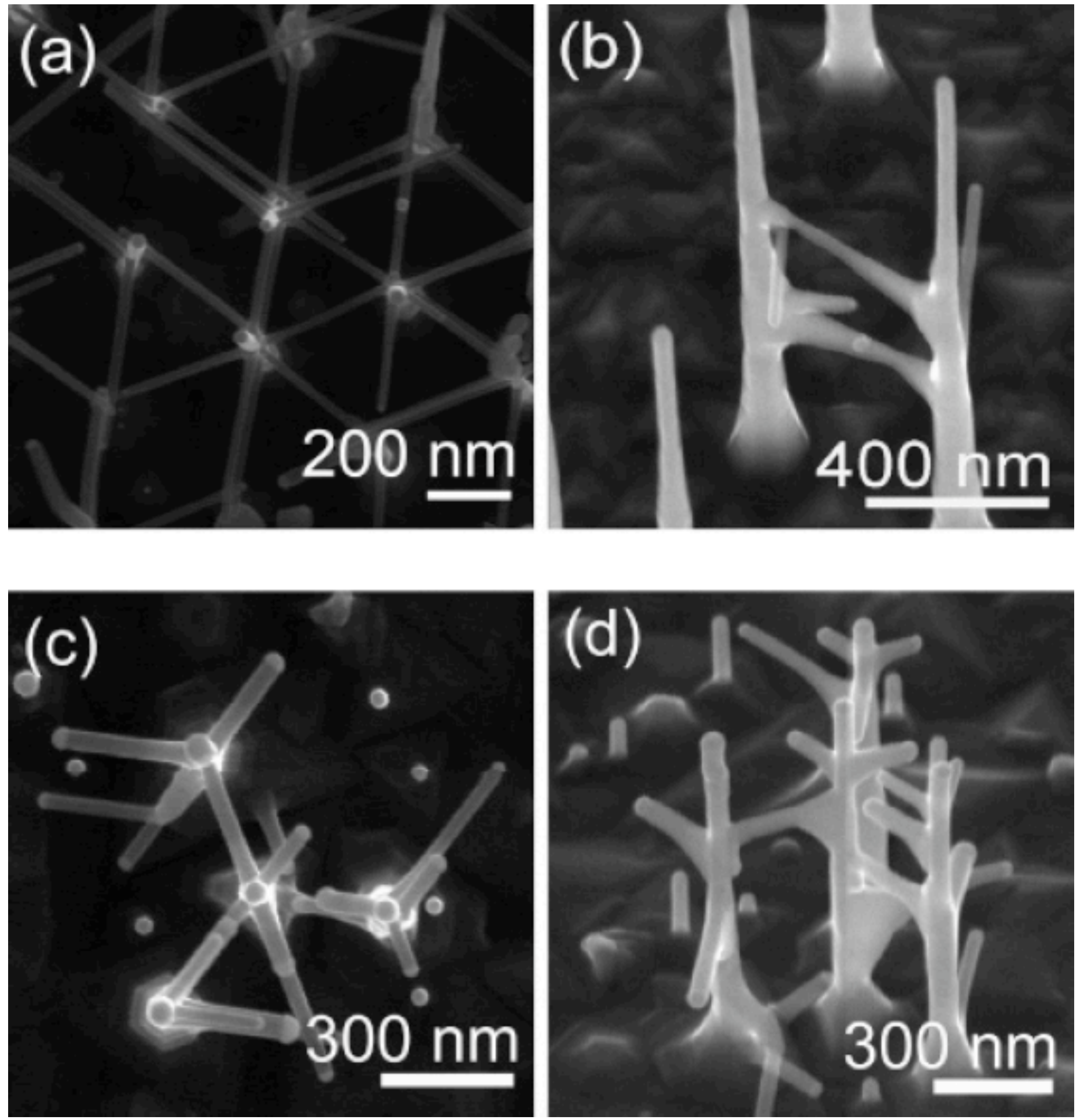


Nanotrådar odlade från ordnade rader med Au-partiklar definierade med elektronstråle-litografi



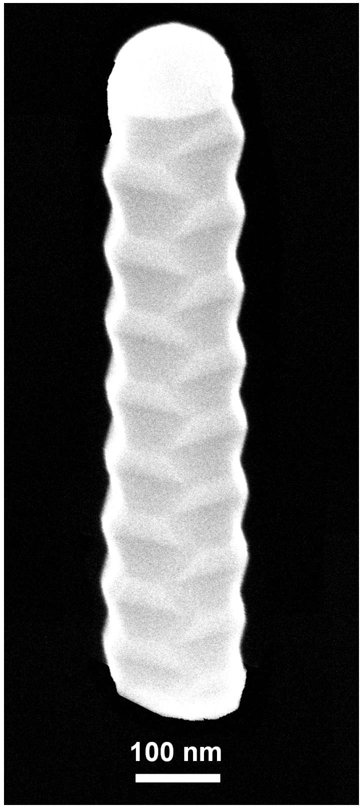
Nanotrådar

Sammanväxta till tredimensionella nätverk

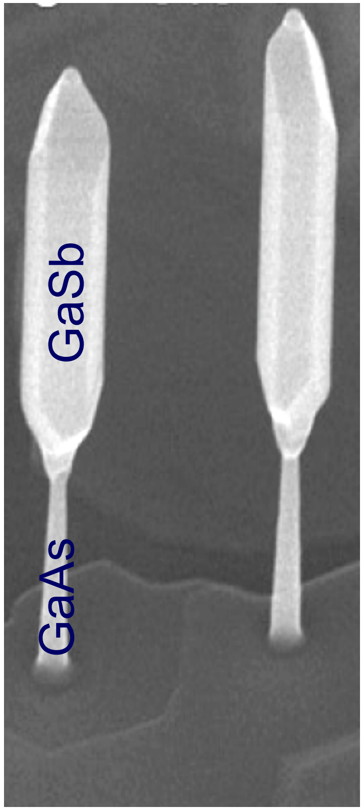


Varför nanotrådar?

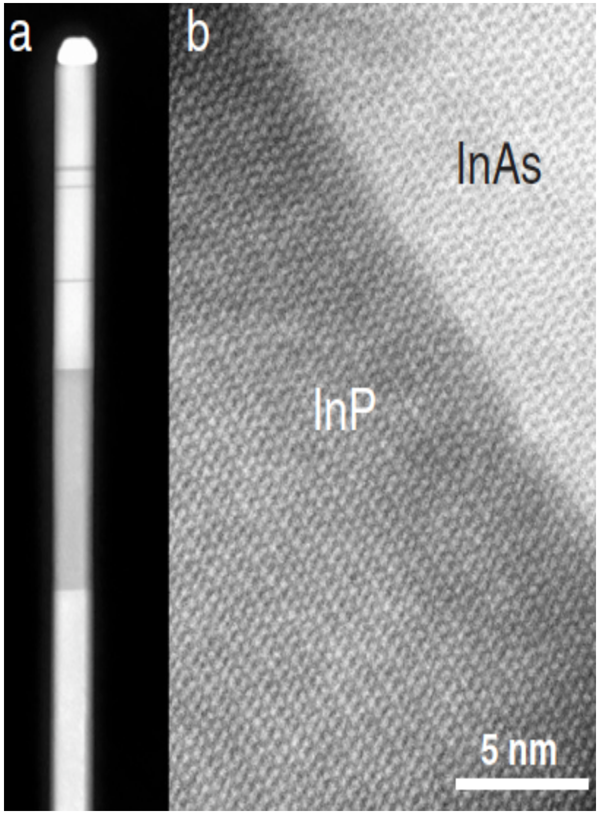
Perfekt kristall-
struktur



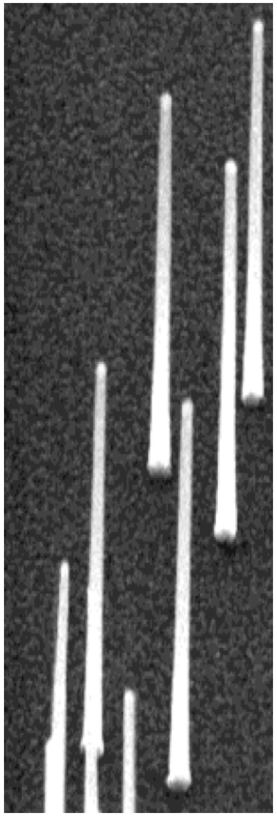
Nya material-
kombinationer



Atomärt skarpa
gränsytor



På “billiga”
kiselsubstrat



Halvledare

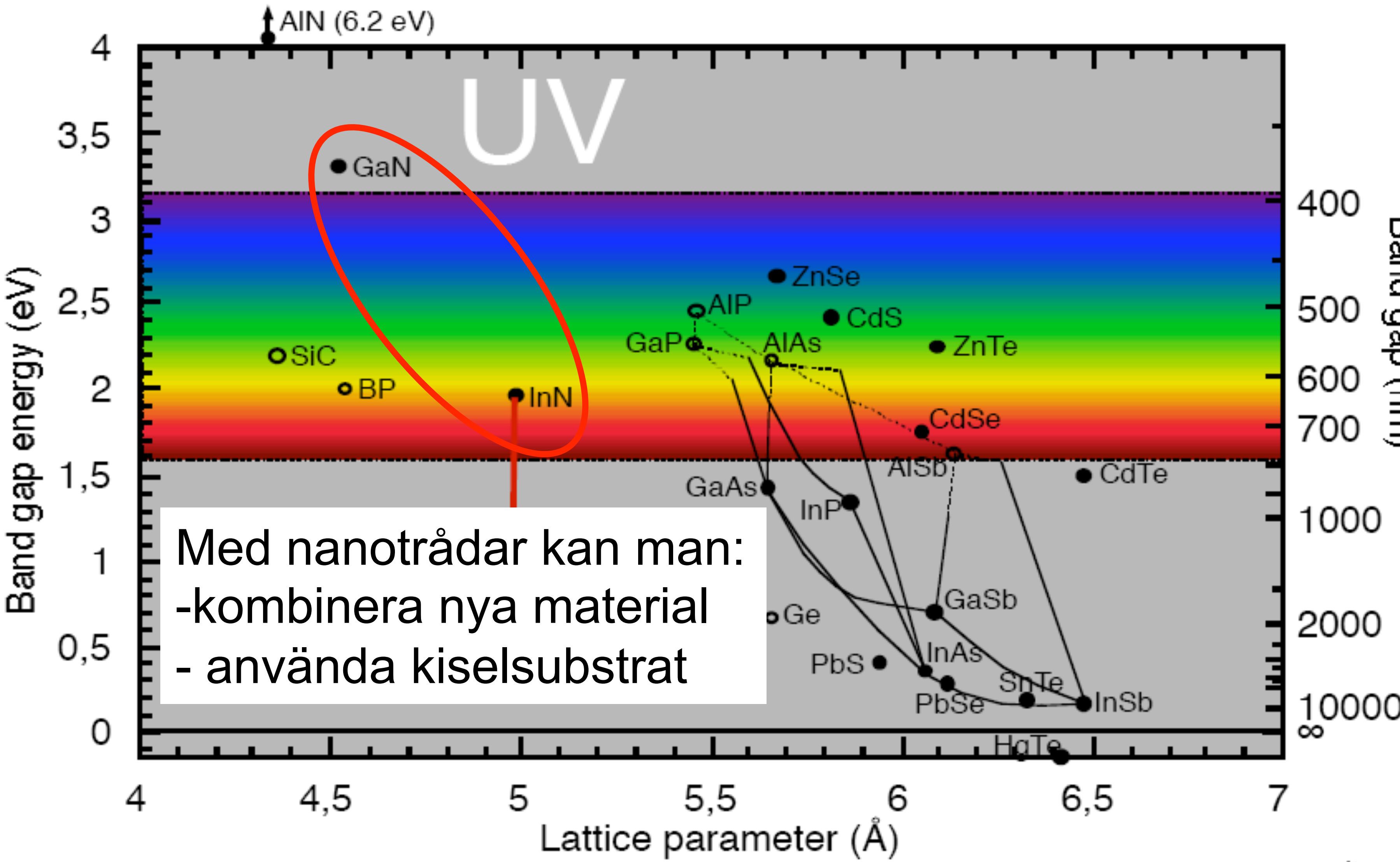
- Grupp IV: Si, Ge
  Transistorer, CCD, solceller, *indirekt bandgap*
- Grupp III-V: GaP, GaAs, InGaAsP…
  LED, lasrar, detektore
- Grupp III-N: GaN, InGaN…
  Blå (& vita) LED, UV lasrar
- Grupp II-VI: HgCdTe…
  IR-kameror

	II	III	IV	V	VI
2		5 B	6 C	7 N	8 O
3	12 Mg	13 Al	14 Si	15 P	16 S
4	30 Zn	31 Ga	32 Ge	33 As	34 Se
5	48 Cd	49 In	50 Sn	51 Sb	52 Te
6	80 Hg		82 Pb		

Periodiska systemet

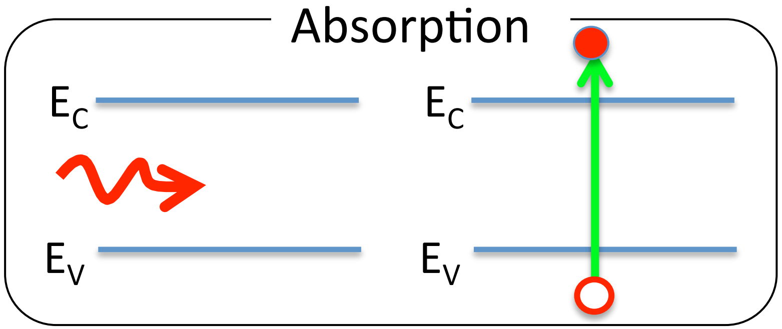
(åtminstone den del som är viktig för en halvledarfysiker)

Band gaps of different semiconductors

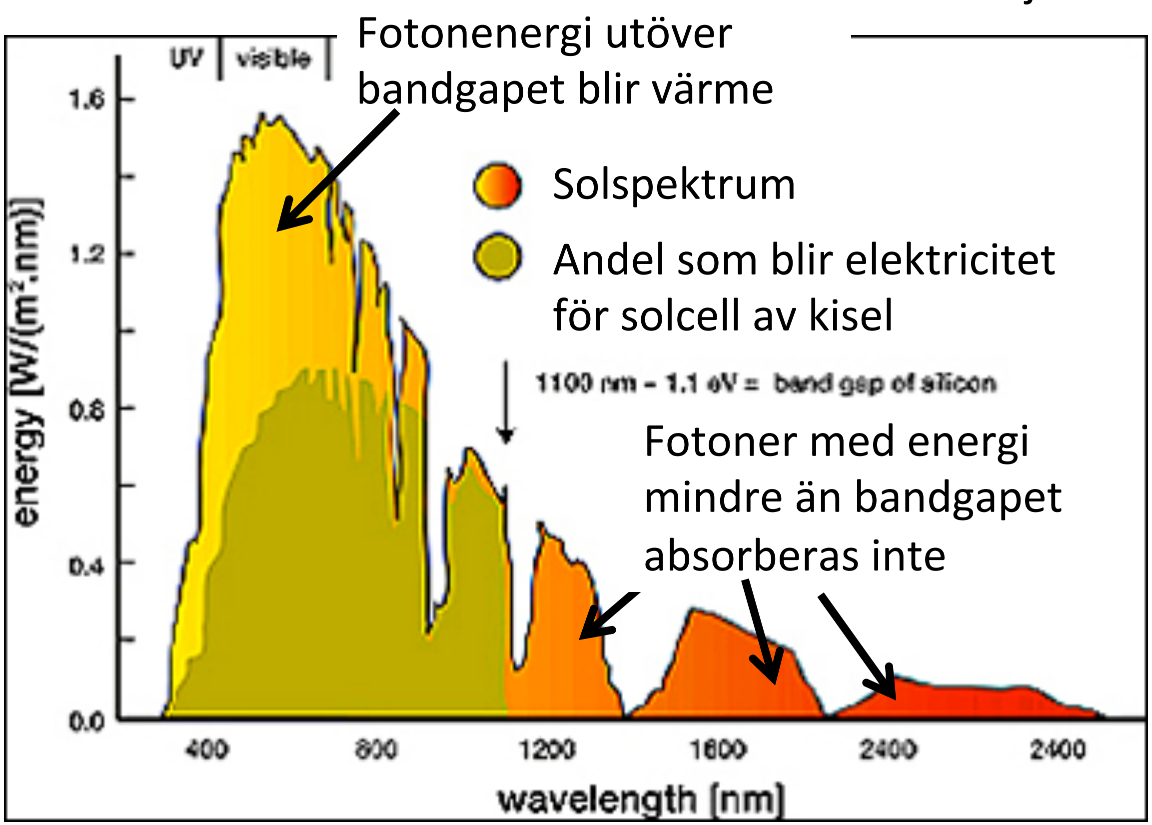


Med nanotrådar kan man:
-kombinera nya material
- använda kiselsubstrat

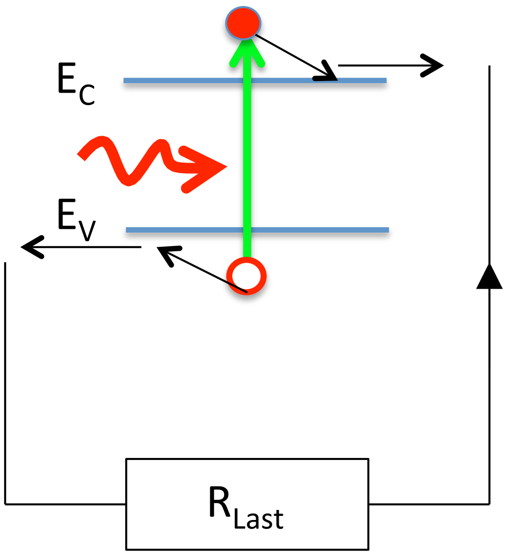
Solcell



Kostnad
Livslängd
Miljö



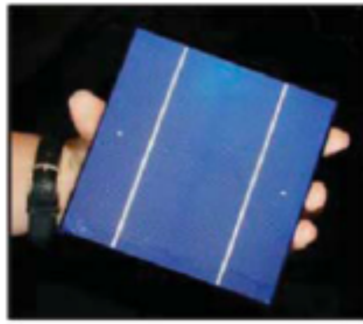
http://solarcellcentral.com



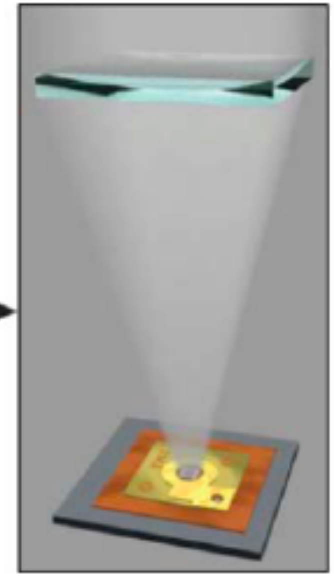
High-Efficiency Multijunction Solar Cells

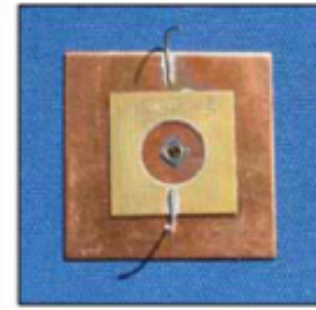
Frank Dimroth and Sarah Kurtz

100 cm² Si solar cell area

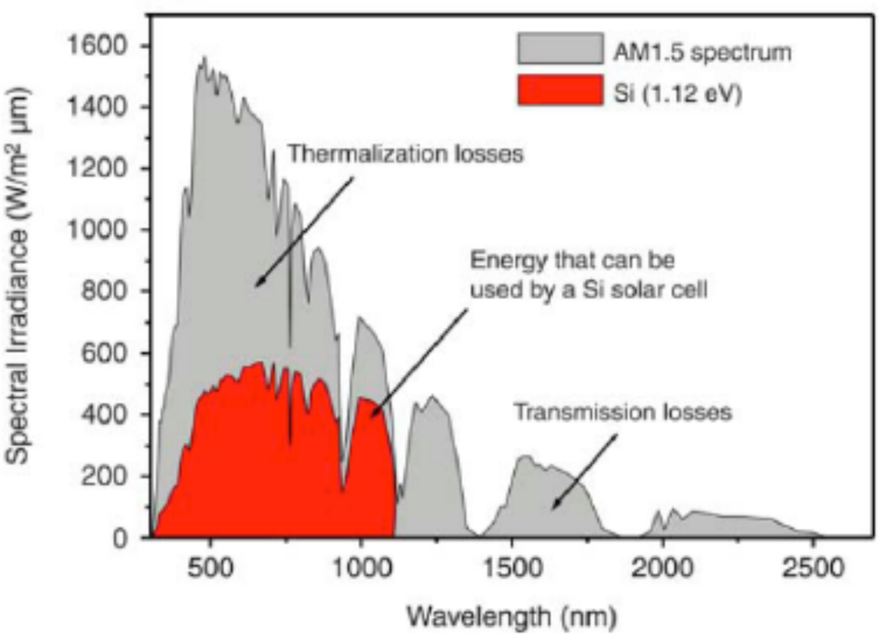


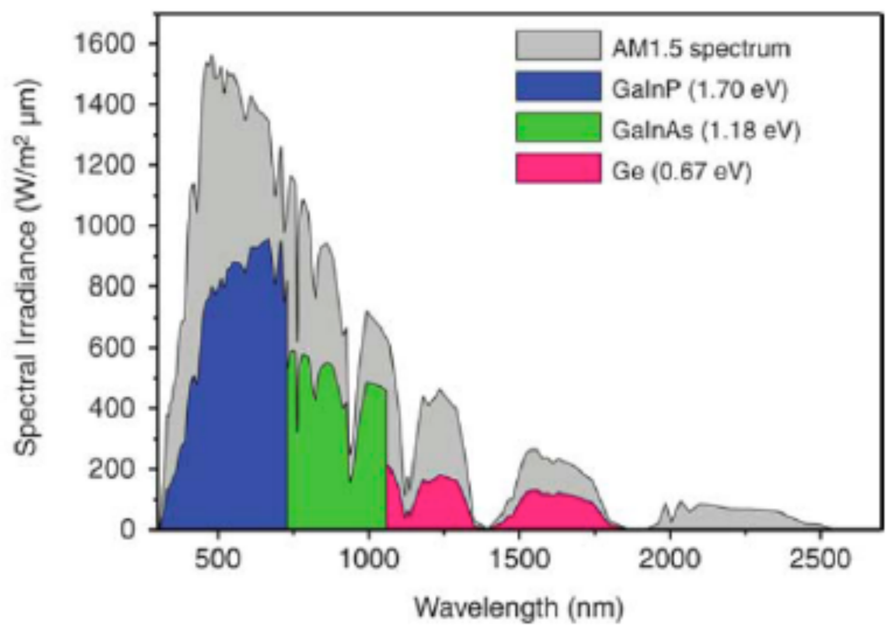
100 cm² lens area





5 mm² multijunction solar cell



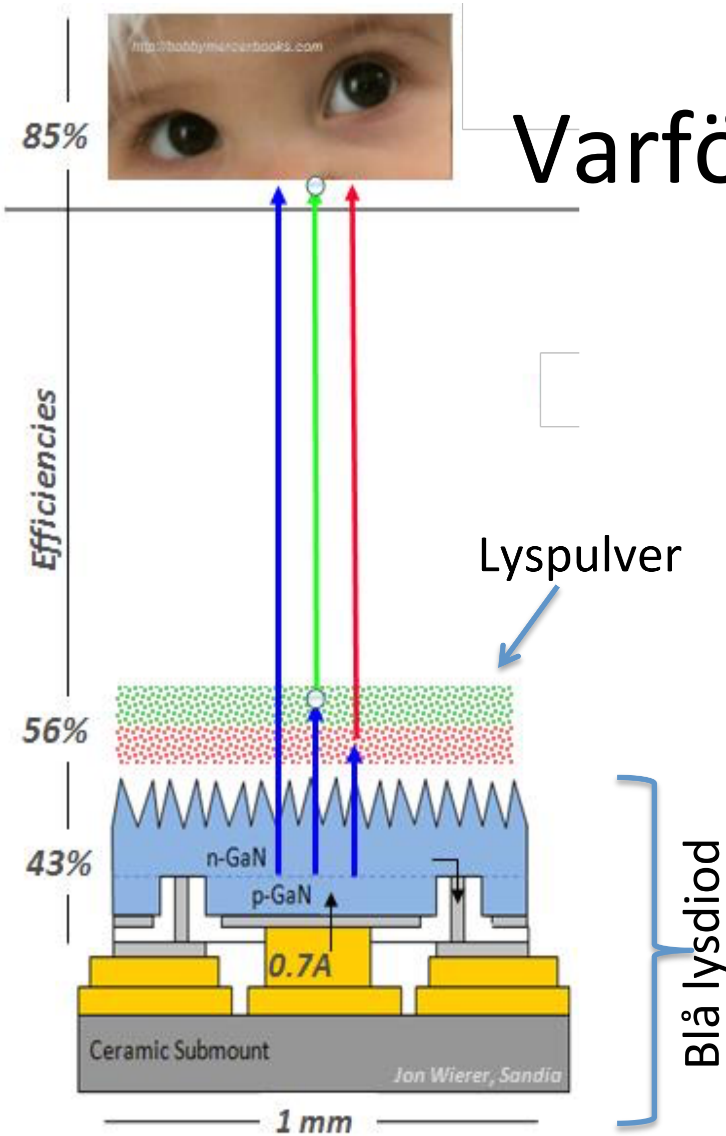


Varför bara 20% effektivitet?

43% Elektricitet -> ljus
  Mer forskning krävs om material & kontakter
  (Redan idag är 80% möjligt vid låga effekter)

56% Ljus -> ljus (innebär förlust som värme)
  Ersätt lyspulvret med grön och röd LED

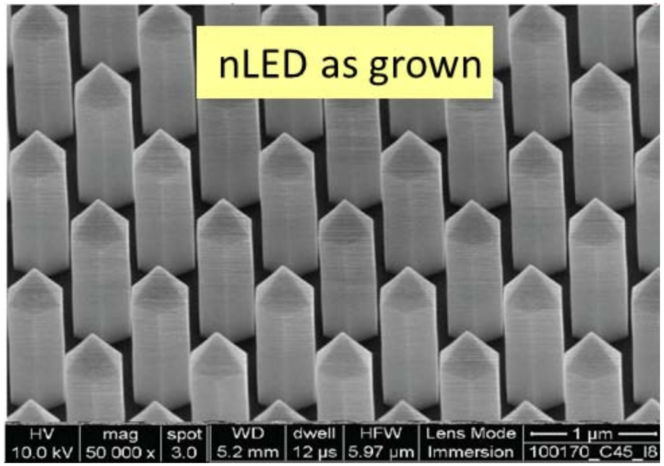
85% Ljus -> synintryck
  Optimera färgerna hos lysdioderna
  Särskilt grönt kräver mer utveckling

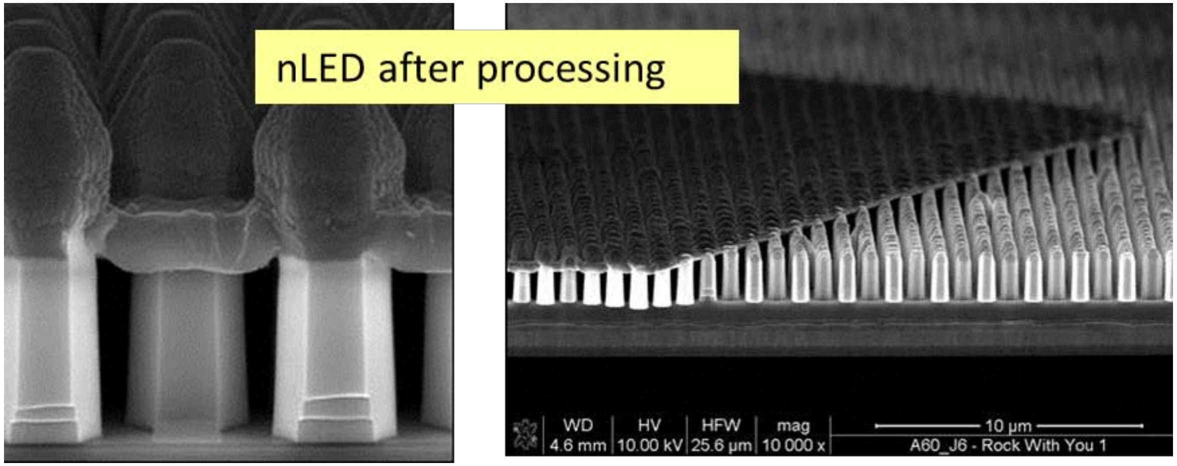


http://energy.sandia.gov/office-of-science/scientific-collaborations/solid-state-lighting-2/overview/beyond-2d-3/

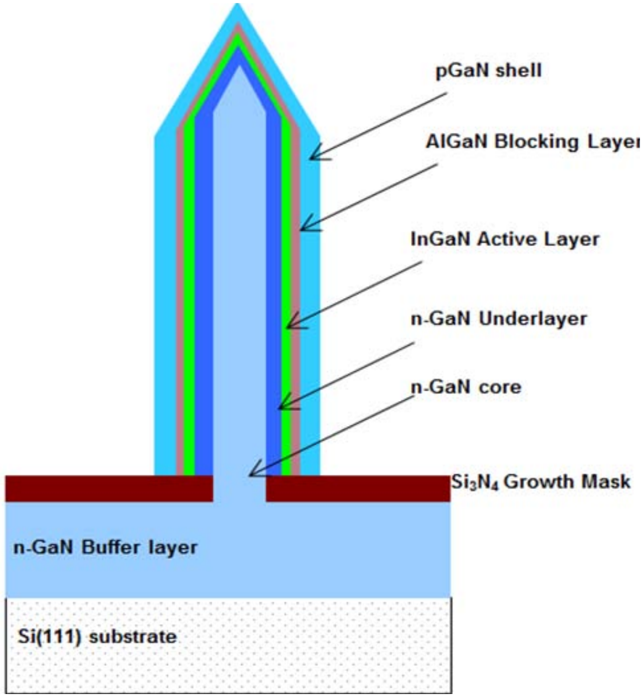
nLEDs

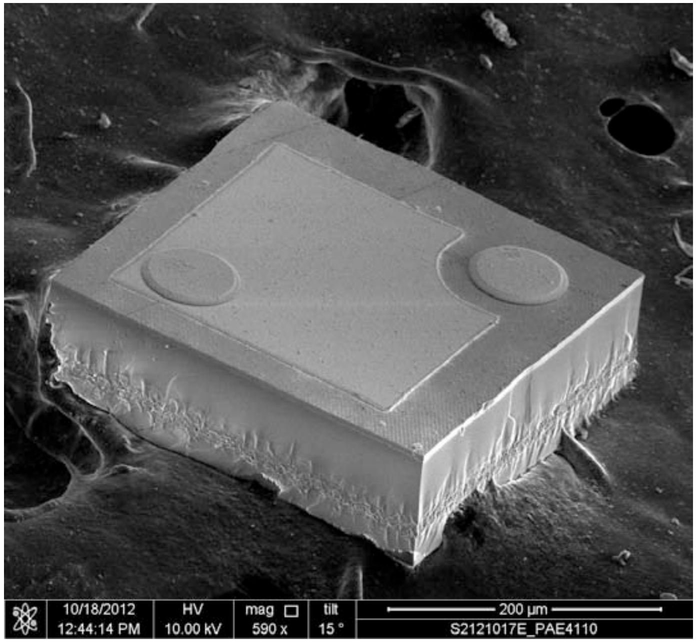
glō™

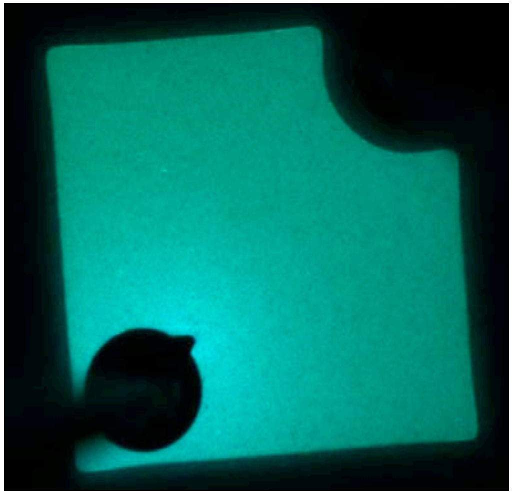




nLED after processing

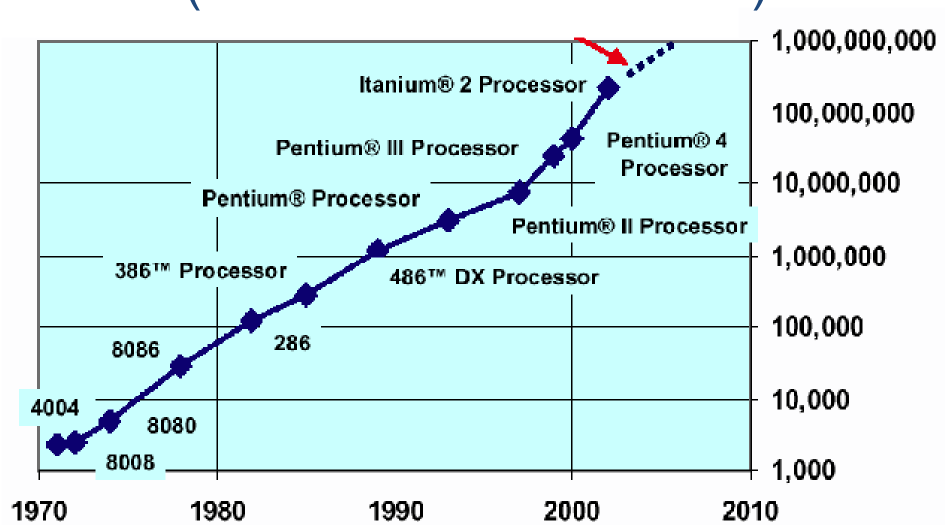




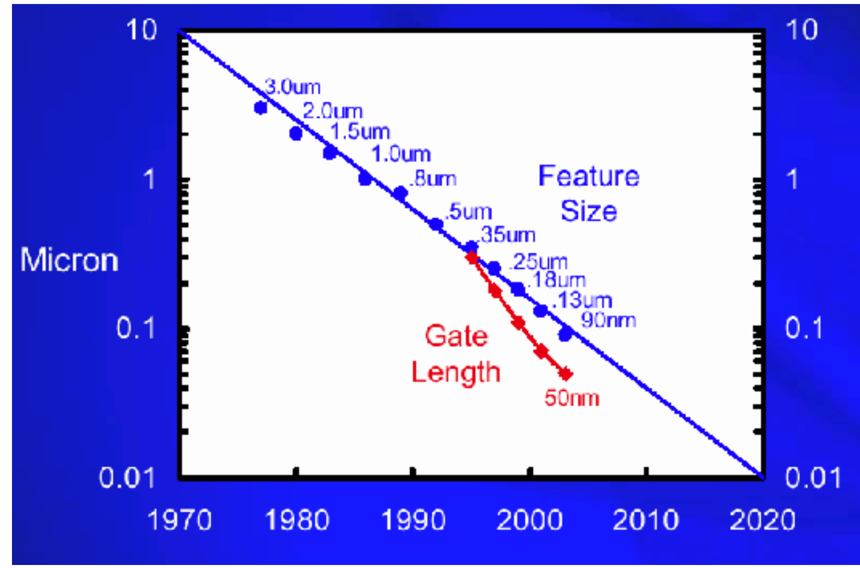


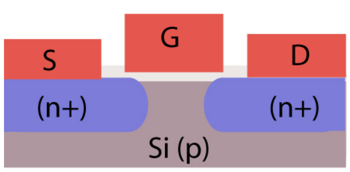
Elektronik

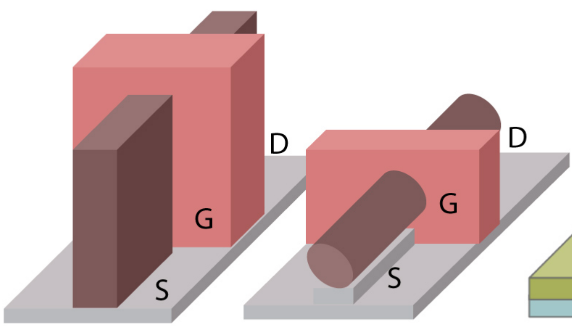
Moores lag: antalet transistorer ökar exponentiellt (fördubblas vartannat år)

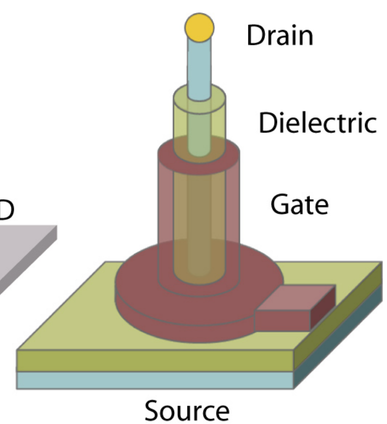


… transistorernas storlek minskar exponentiellt









Nya transistorkoncept krävs, t ex nanotrådsbaserad fälteffekttransistor (FET)