

BLACK SILICON

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Outline

- ▶ **Black silicon: what is it?**

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- ▶ **Conditions for formation**

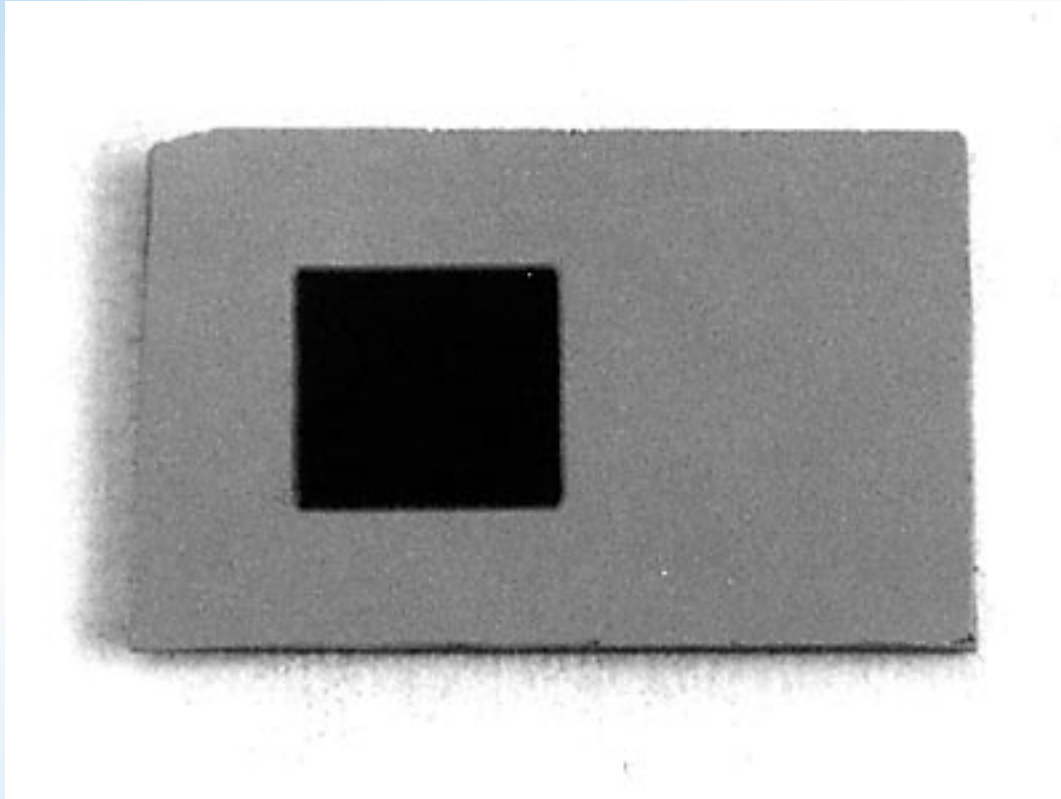
Outline

- ▶ **Black silicon: what is it?**
- ▶ **Conditions for formation**
- ▶ **Mechanism**

Outline

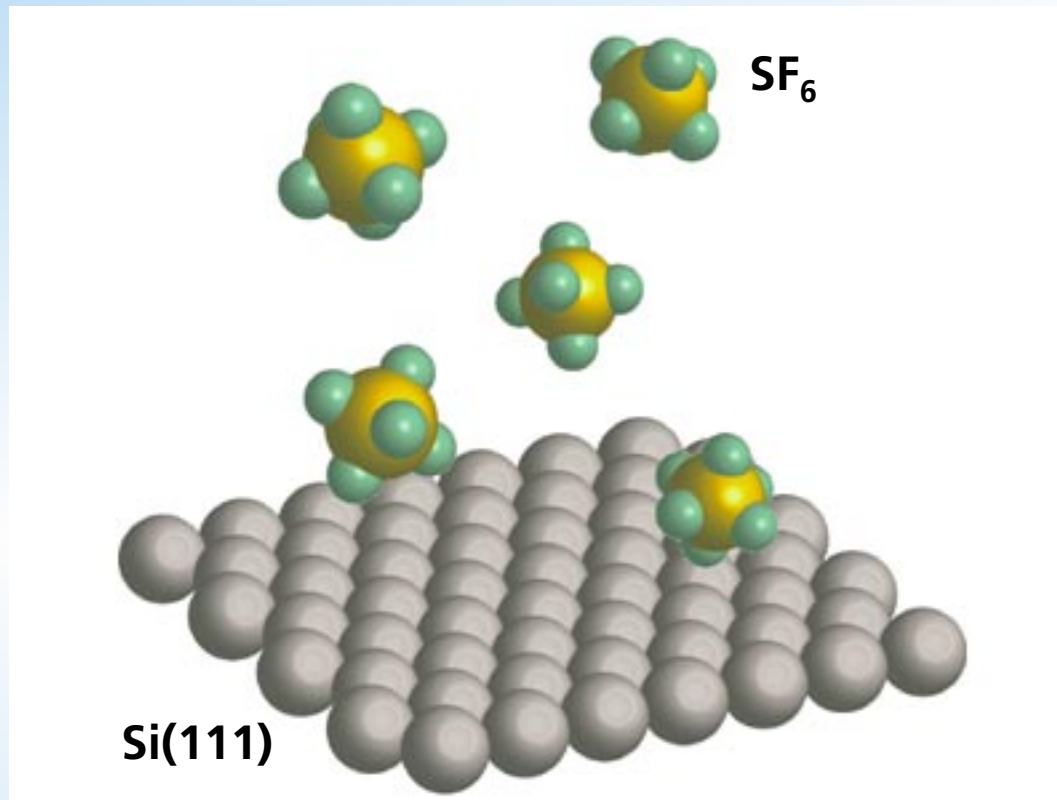
- ▶ **Black silicon: what is it?**
- ▶ **Conditions for formation**
- ▶ **Mechanism**
- ▶ **Light absorption**

Black Silicon: what is it?



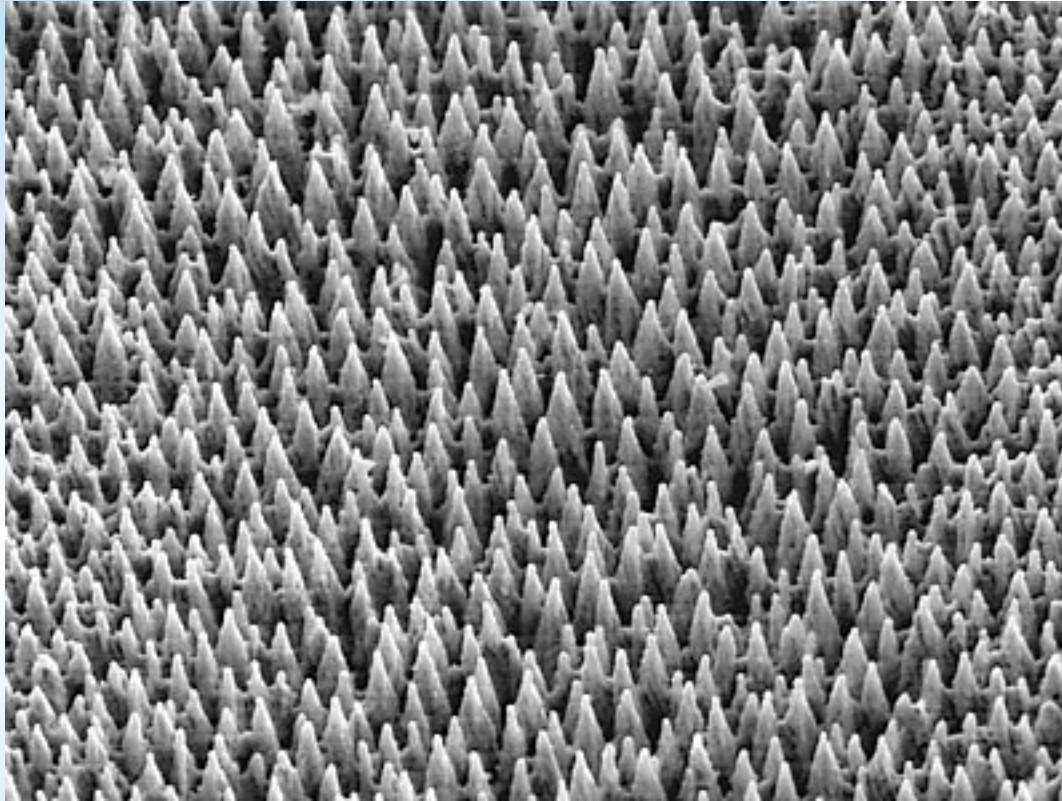
5 mm

Black Silicon: what is it?



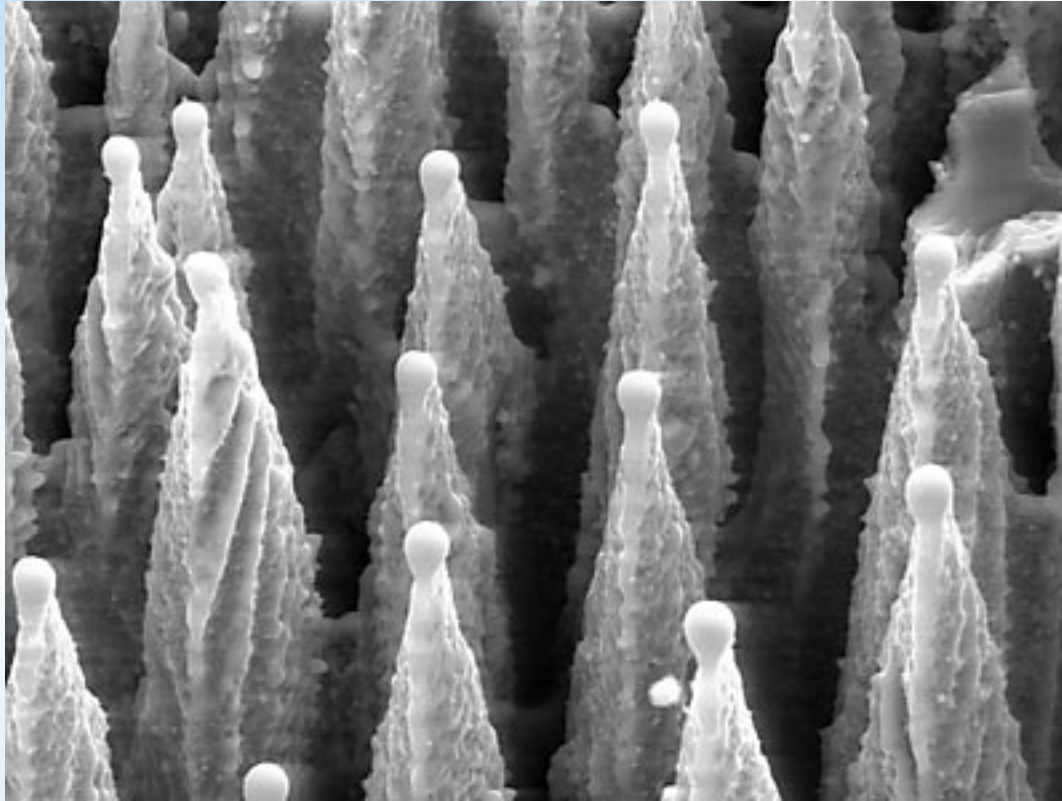
irradiate with 100 fs 10 kJ/m² laser pulses

Black Silicon: what is it?



20 μm

Black Silicon: what is it?

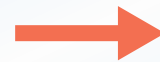


4 μm

Conditions for formation

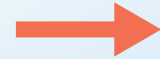
Effects of Gas

SF₆, Cl₂



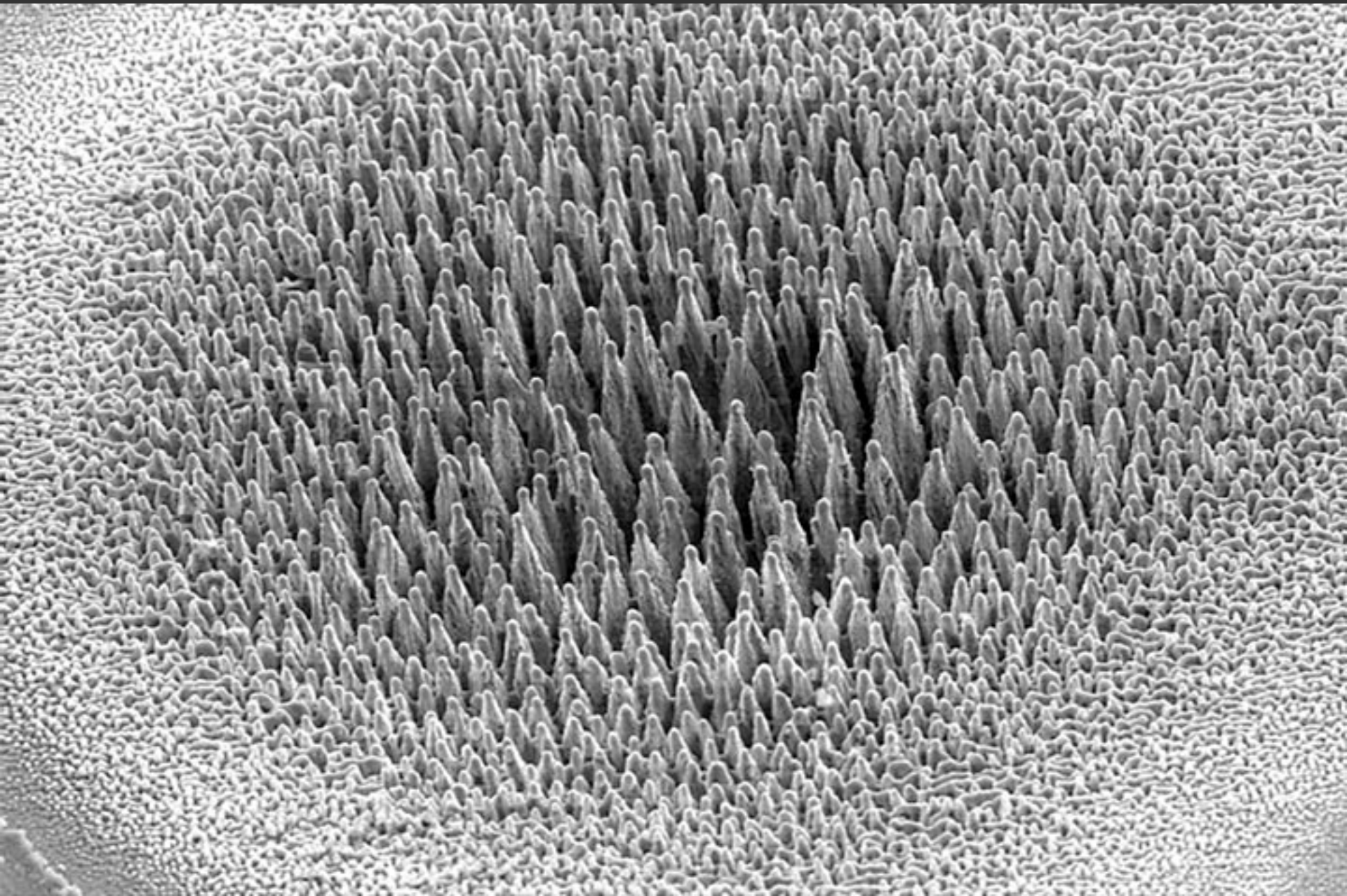
sharp spikes

N₂, He, Ar, air, vacuum

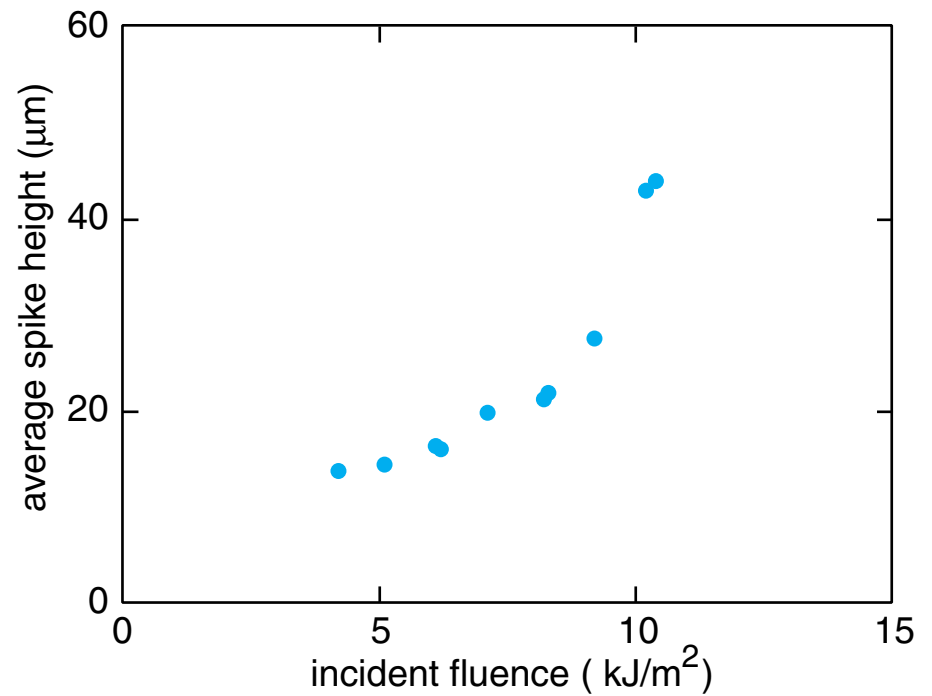


blunt structures

Conditions for formation

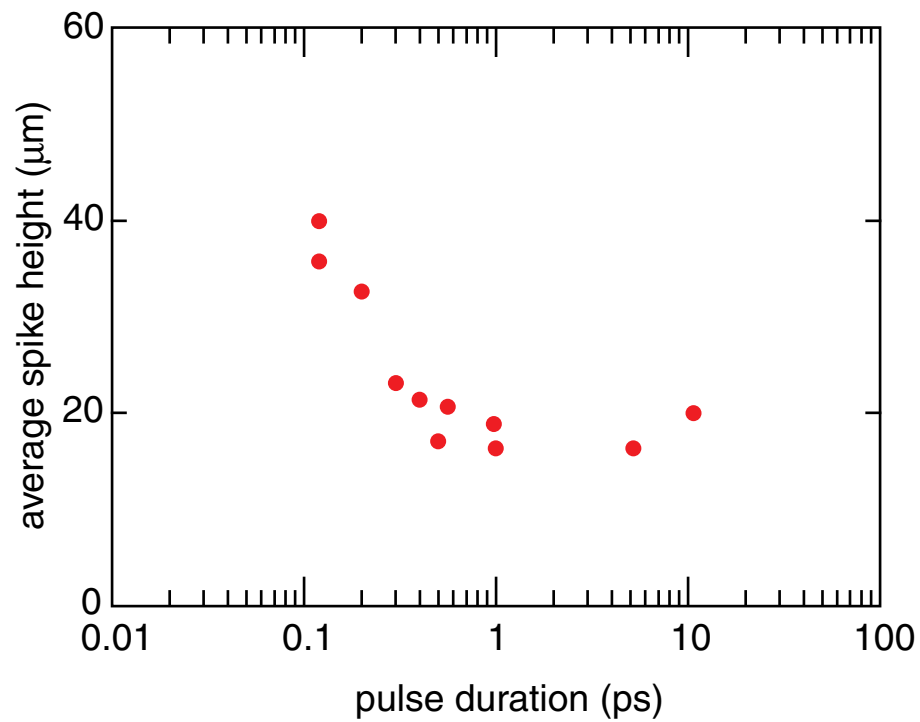


Conditions for formation



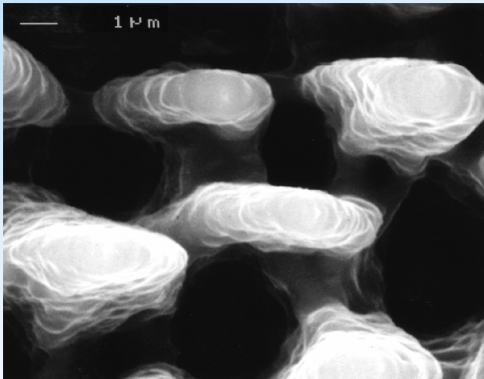
Conditions for formation

pulse duration dependence

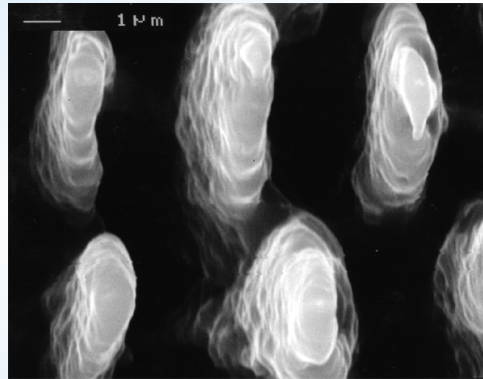


Conditions for formation

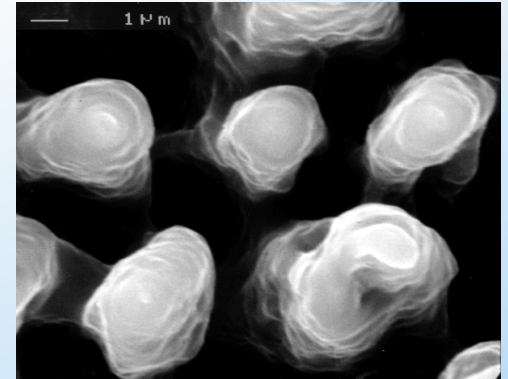
s-polarized

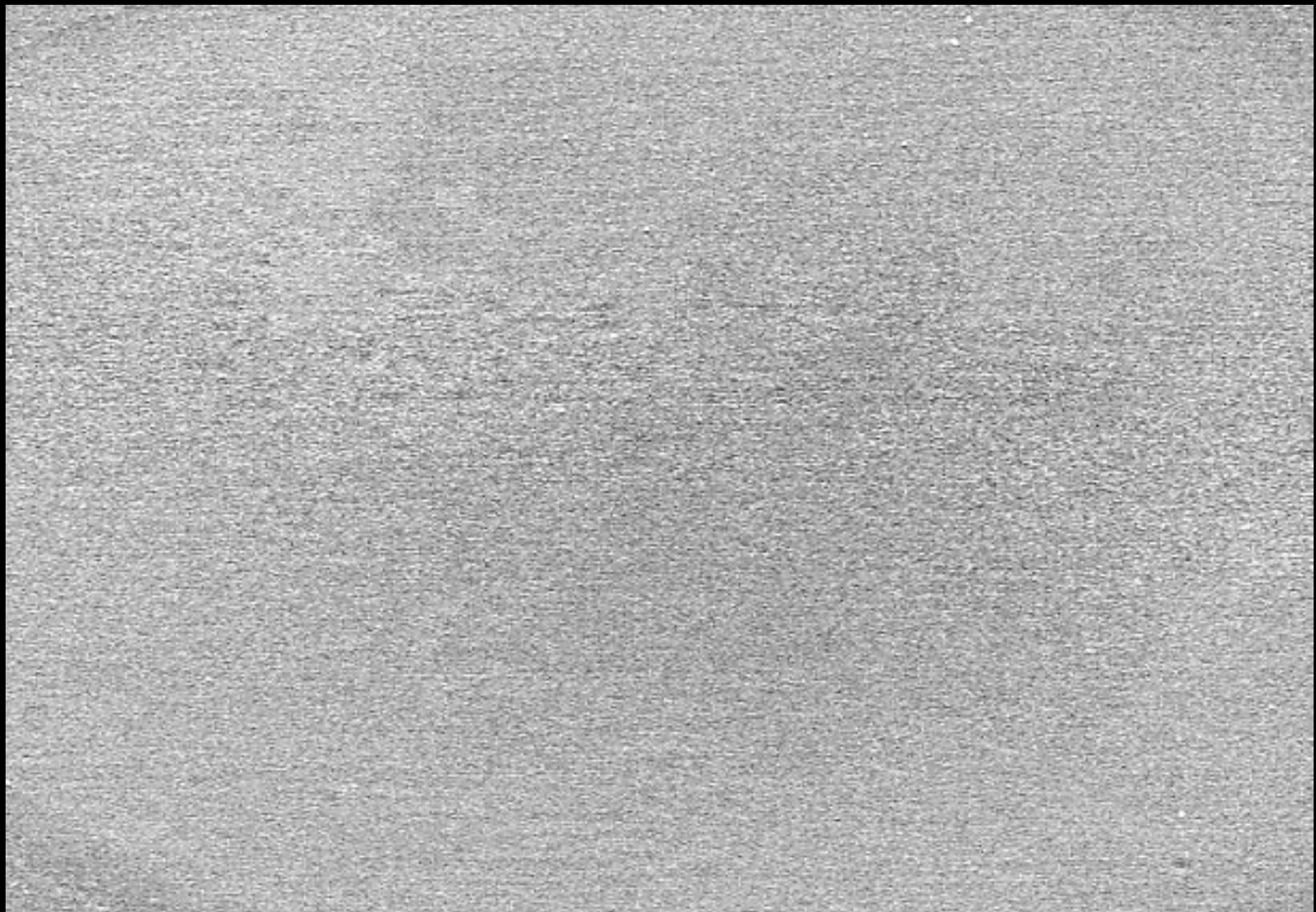


p-polarized



circularly polarized





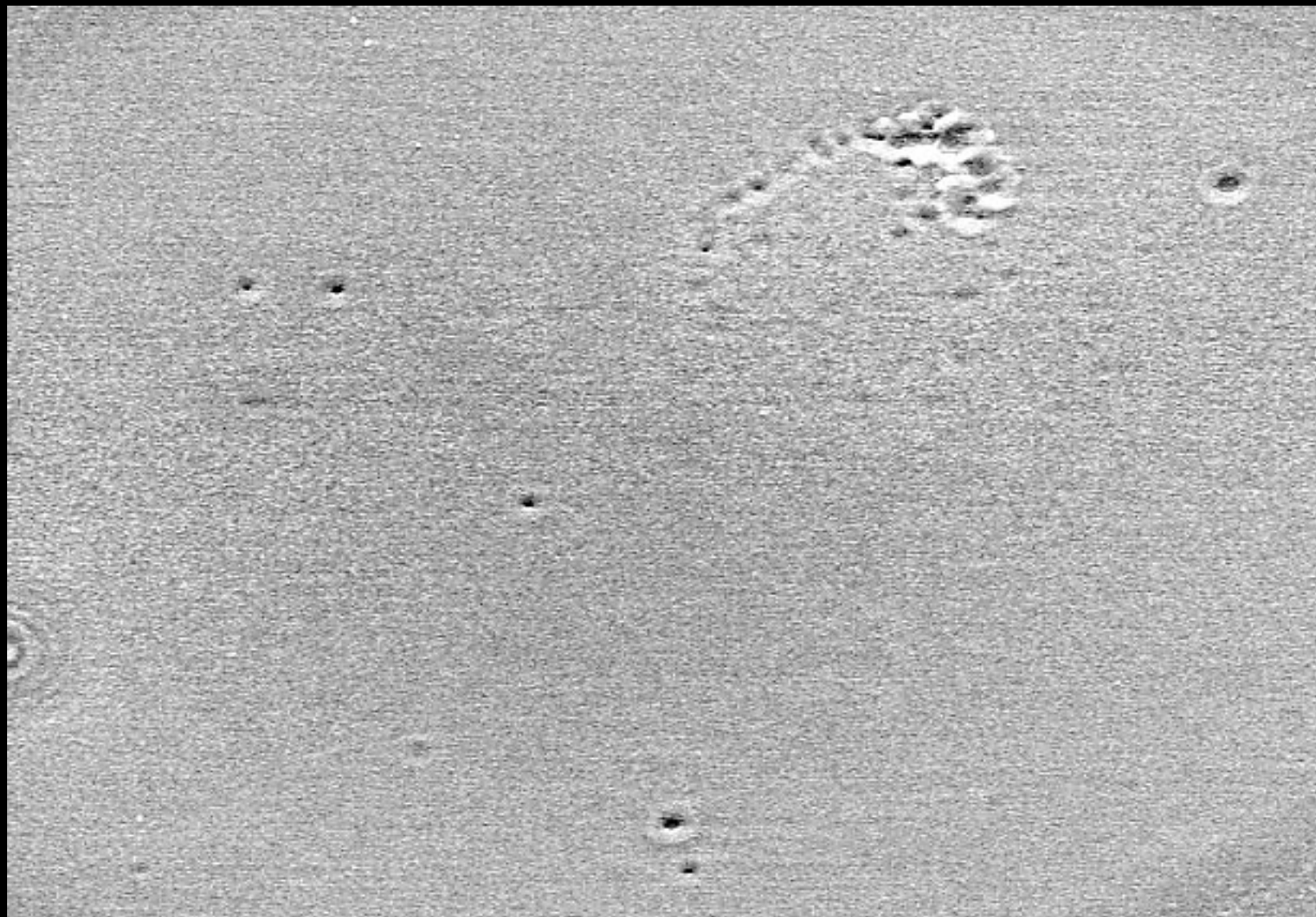
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0000



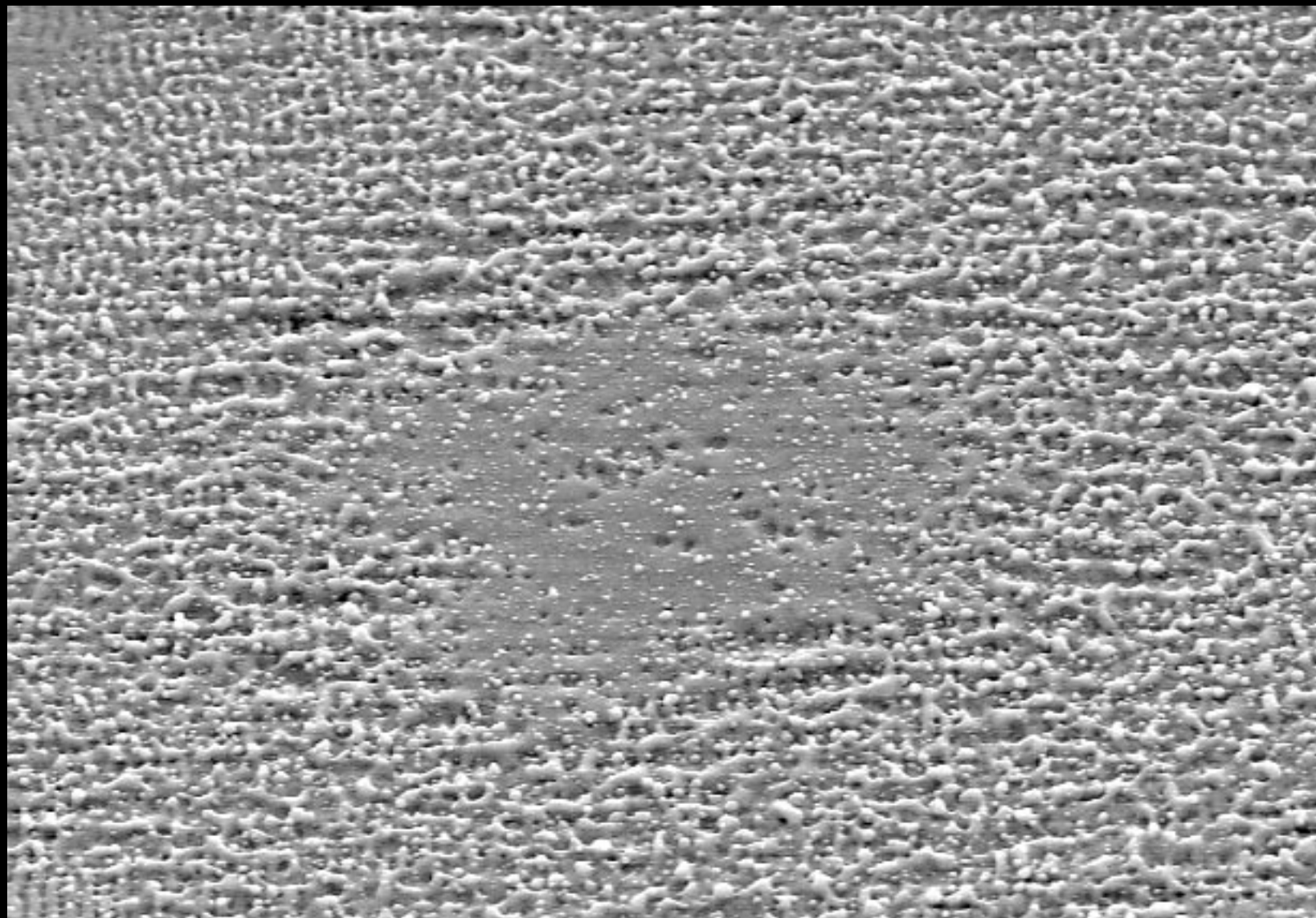
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0001



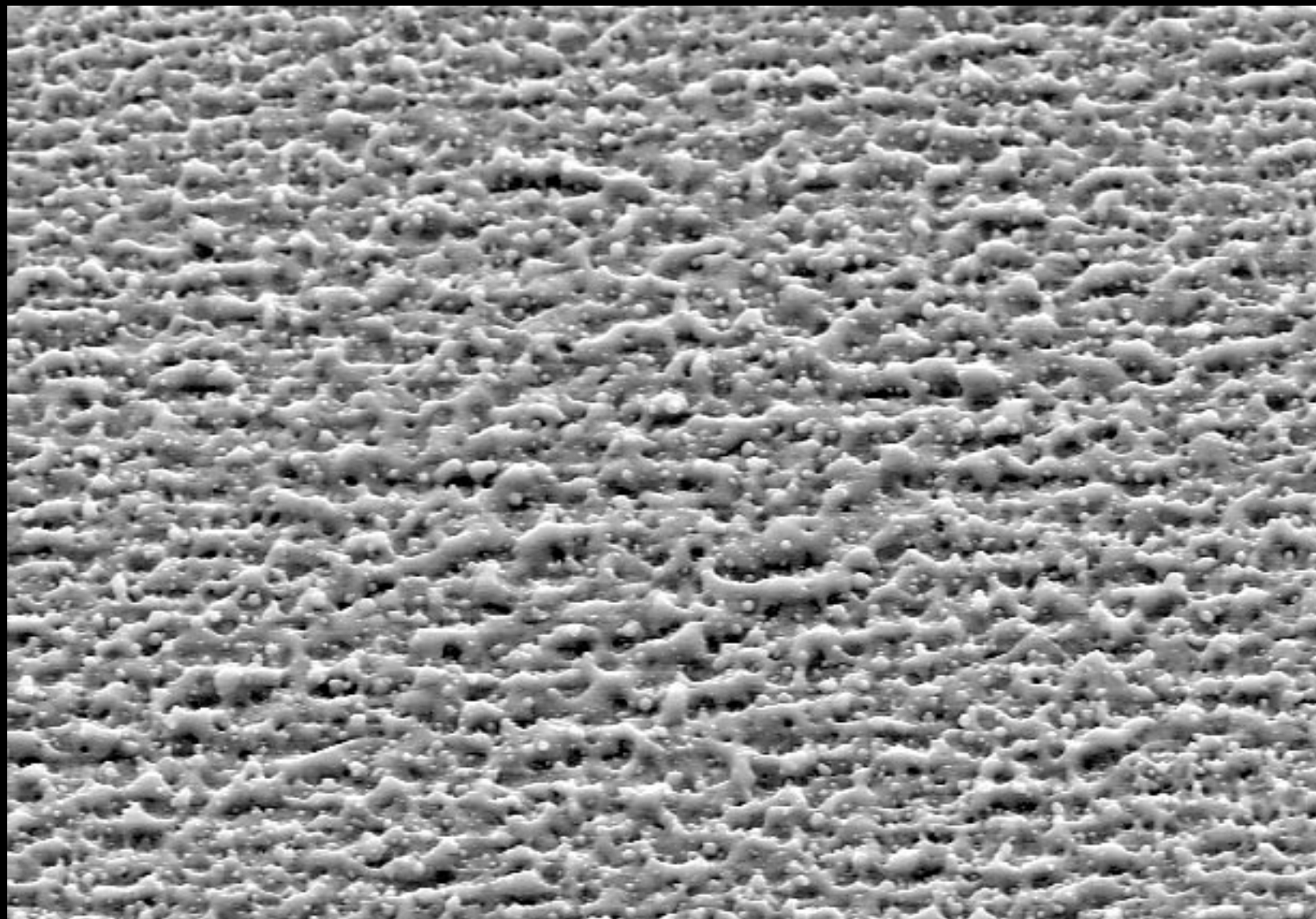
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0005



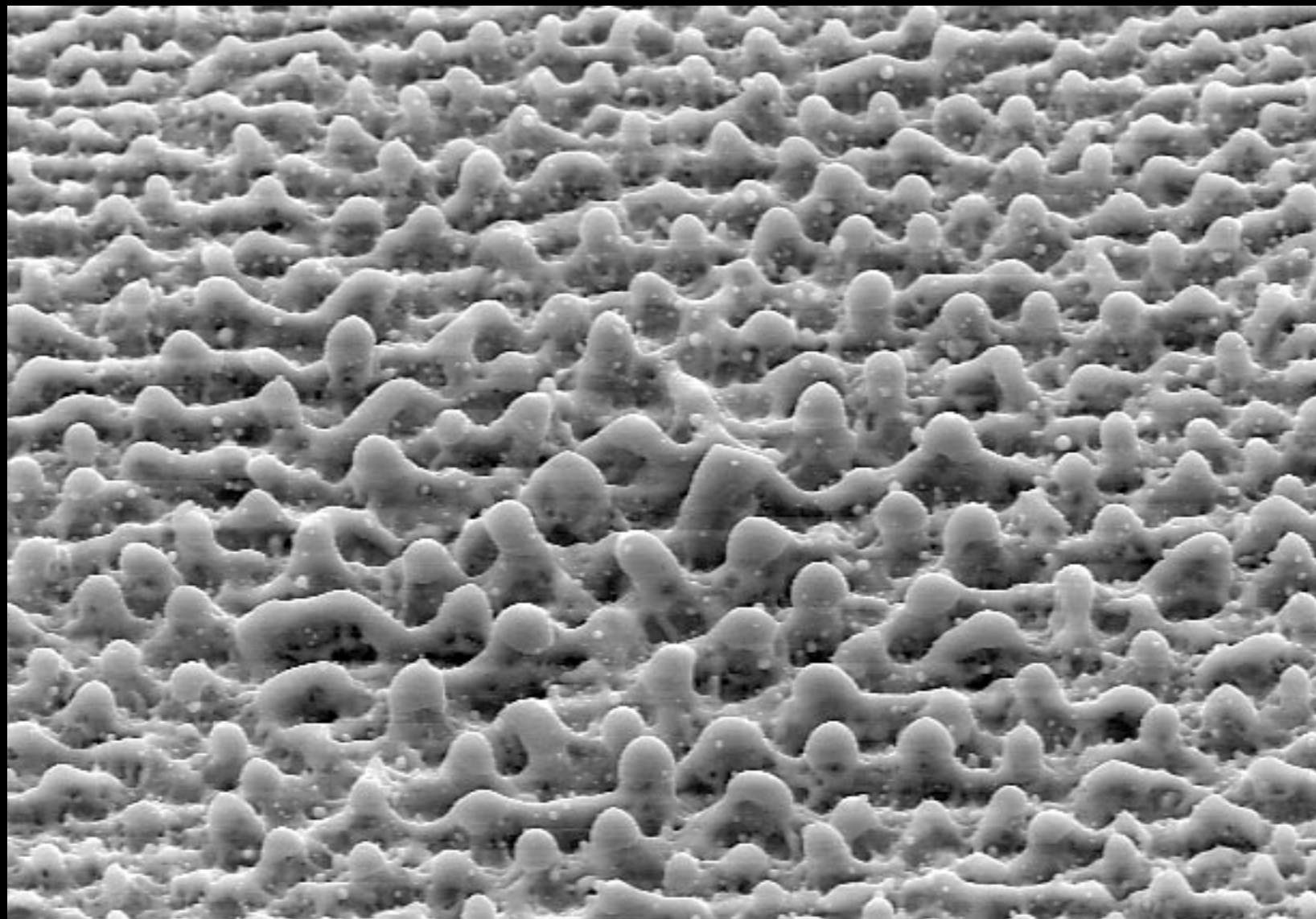
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0010



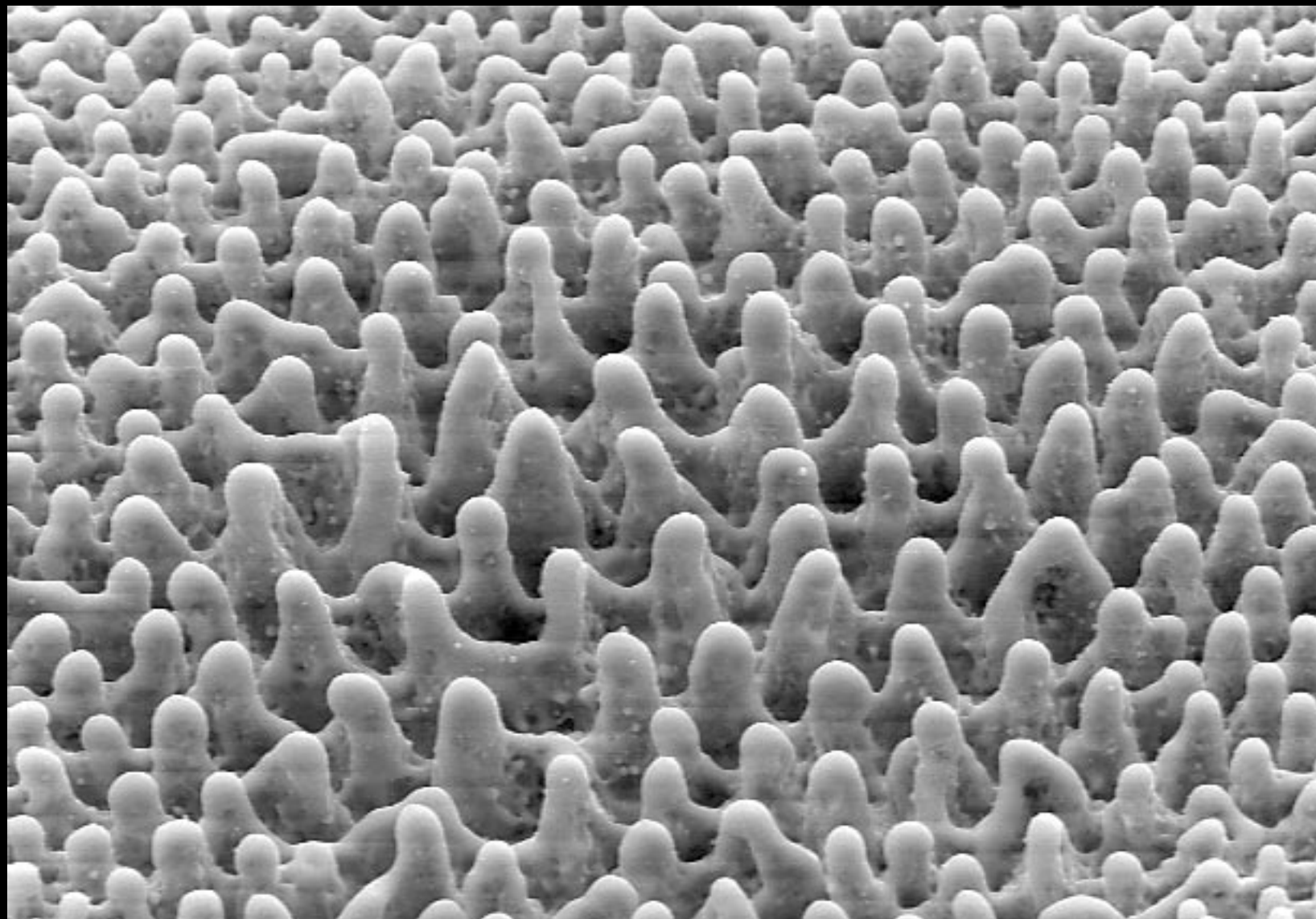
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0025



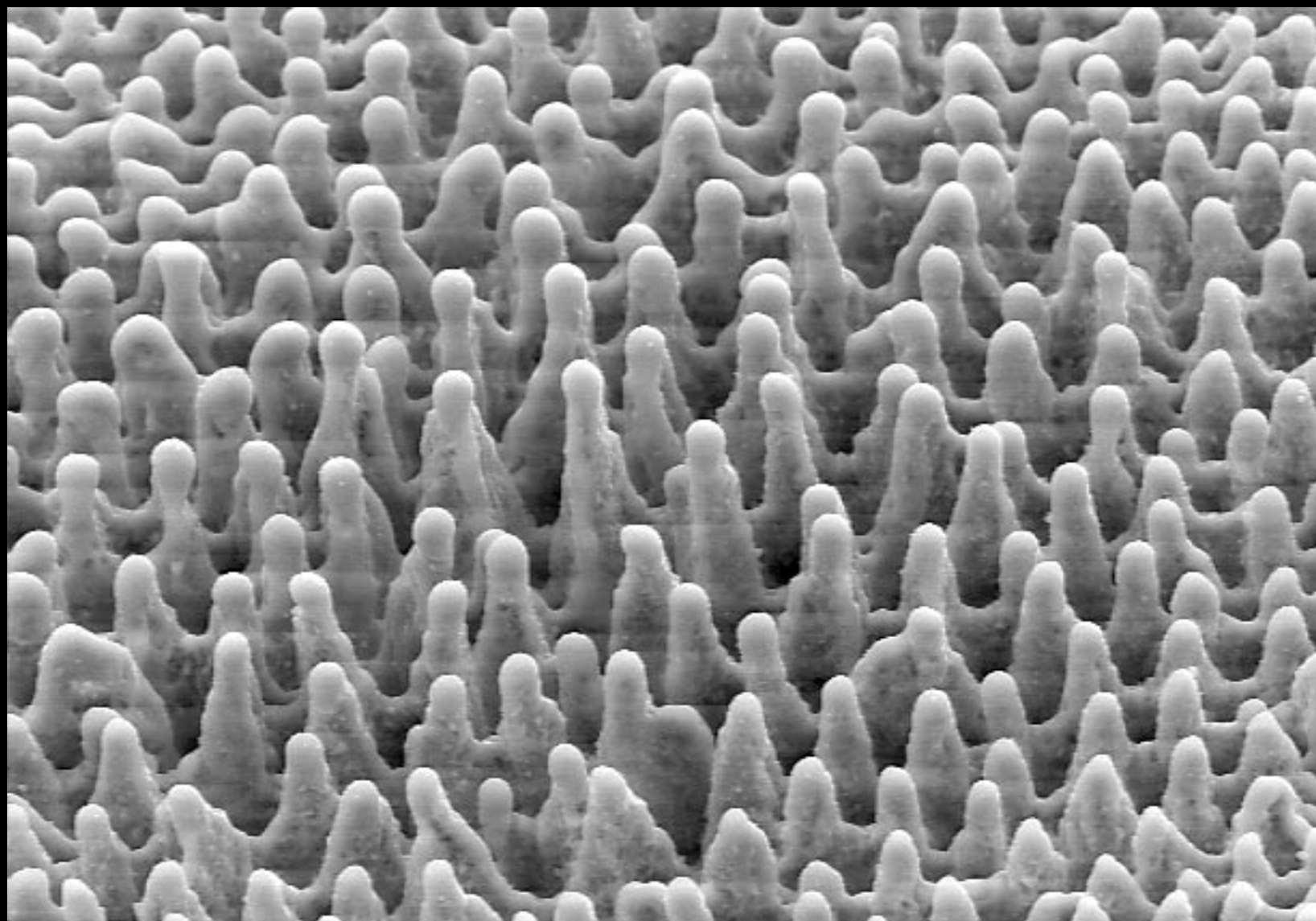
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0050



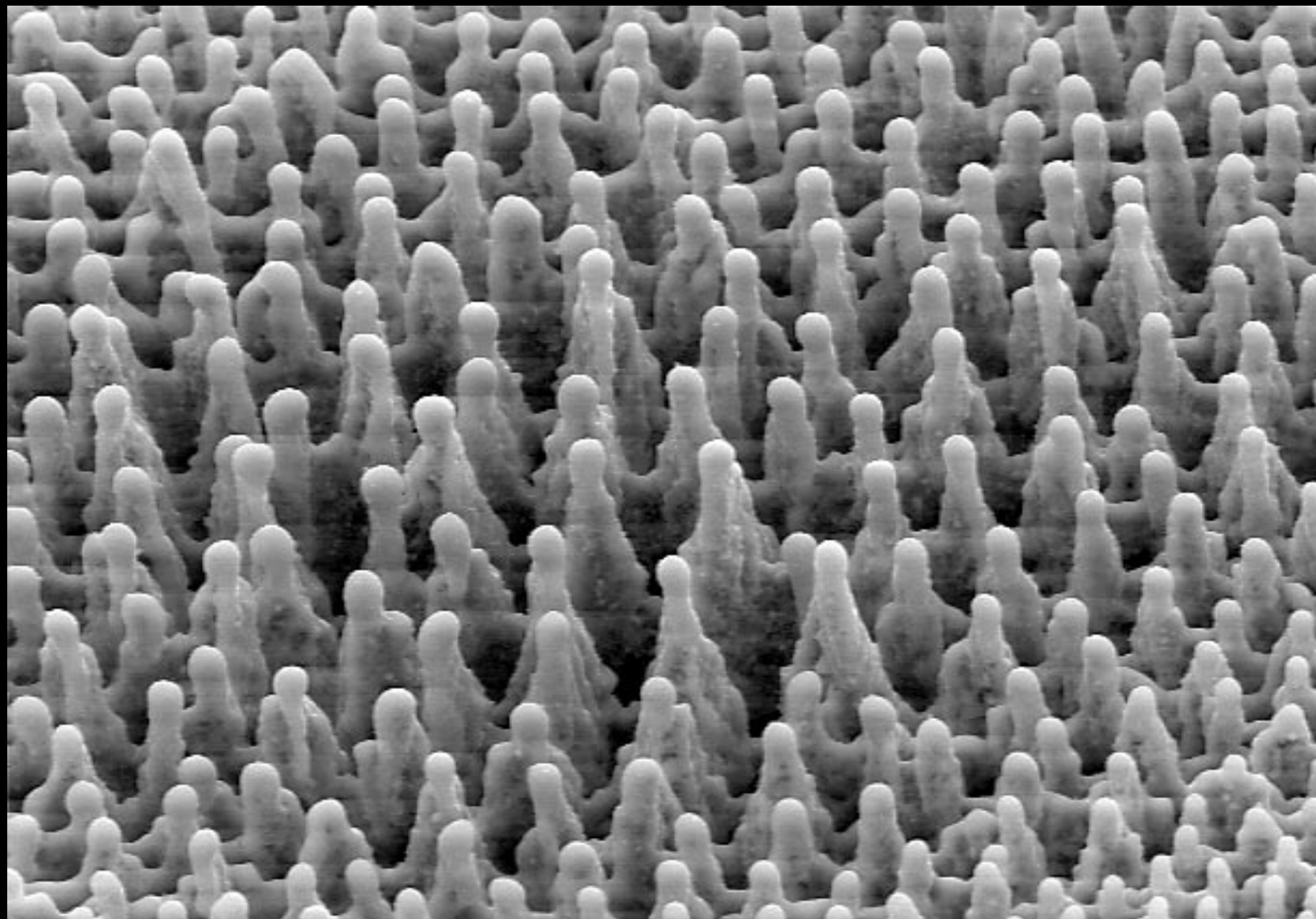
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0075



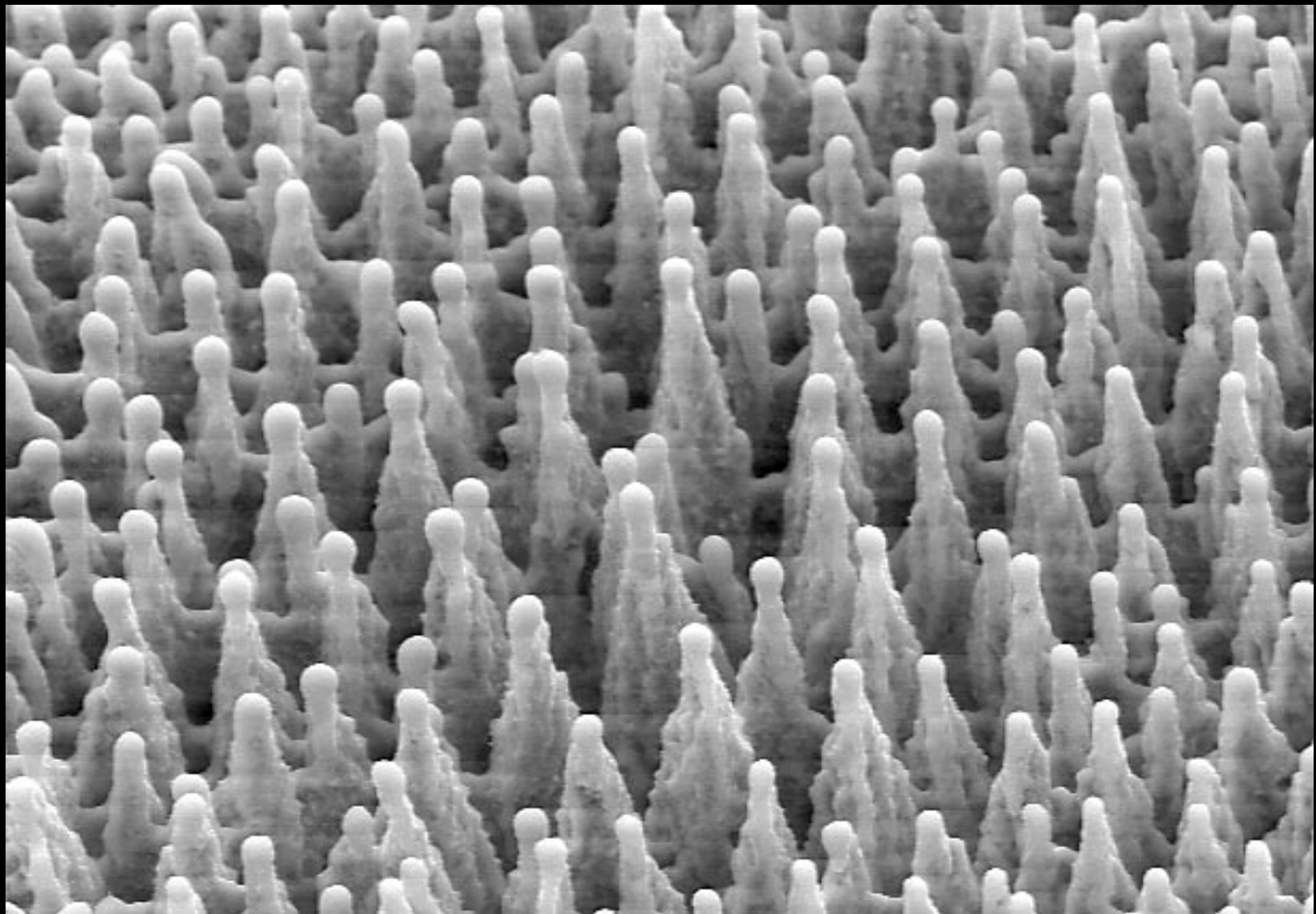
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0125



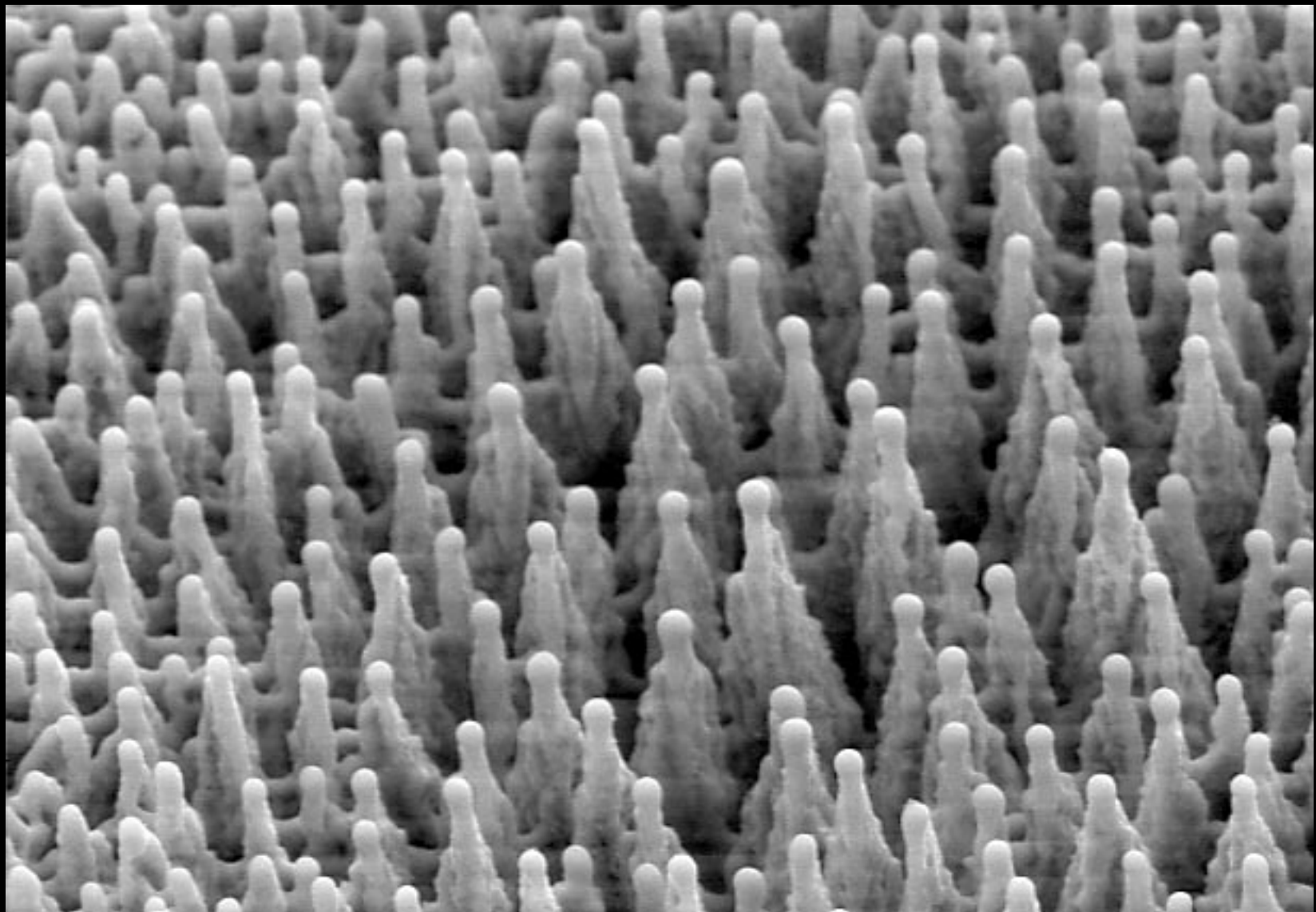
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0250



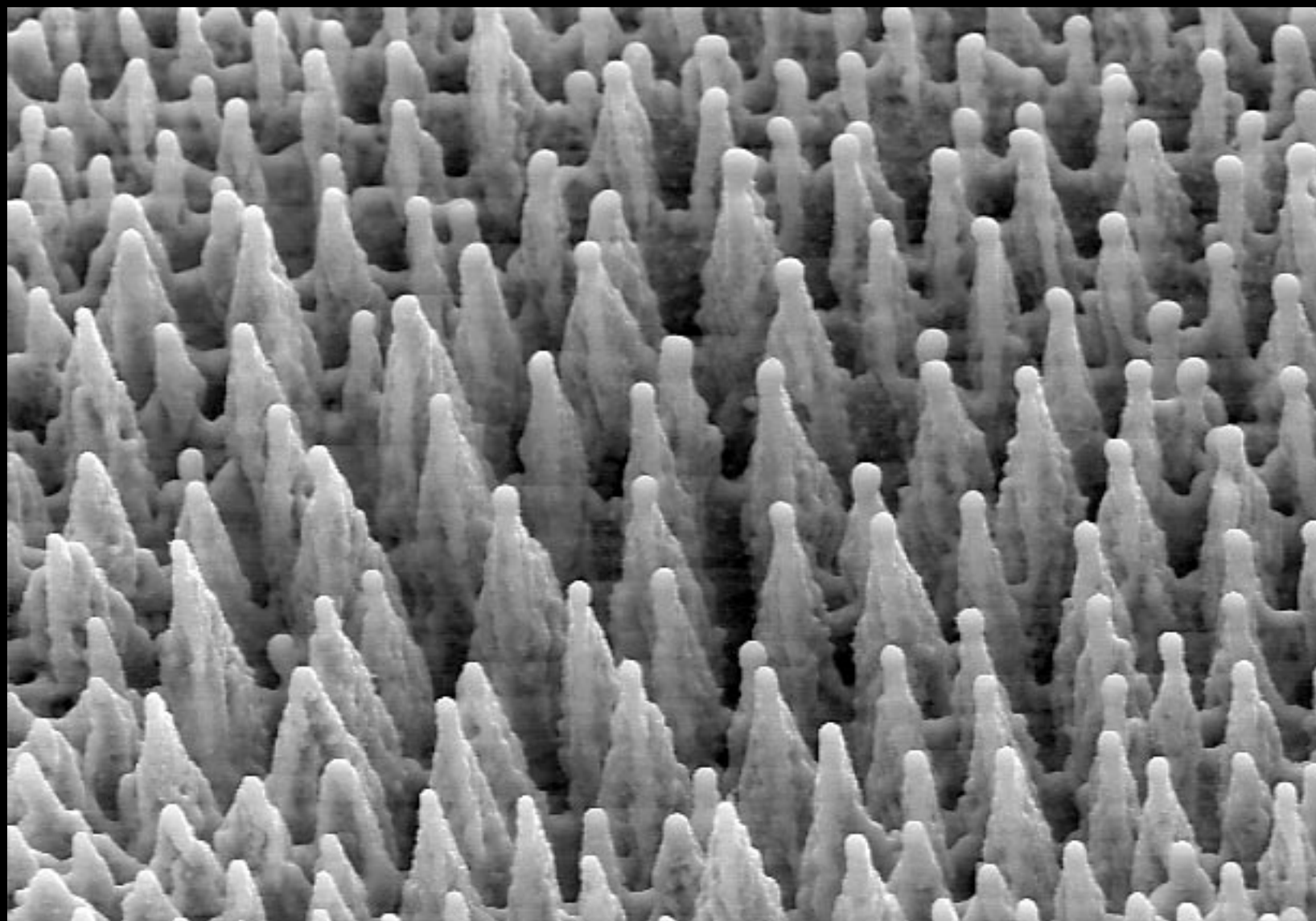
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0350



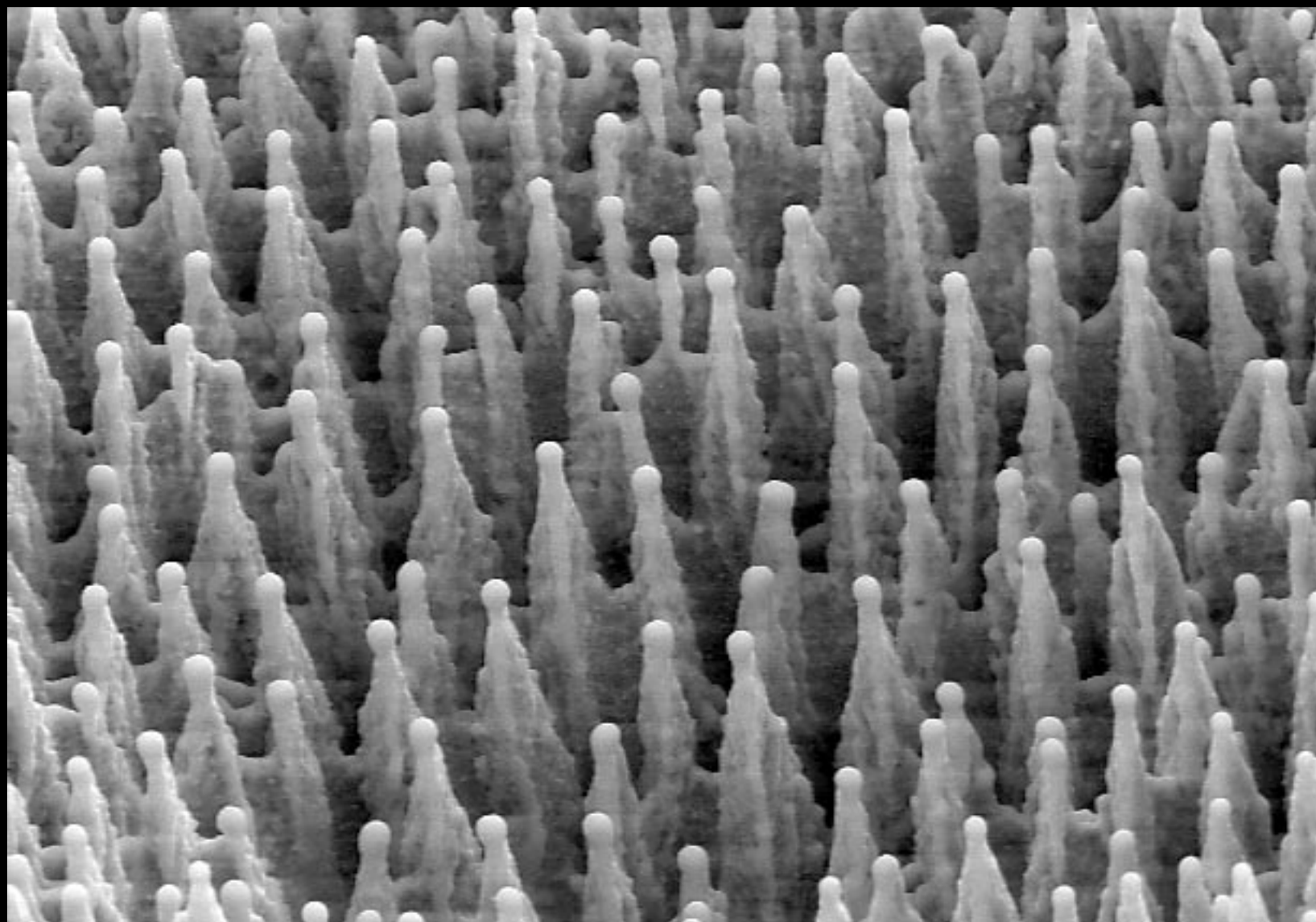
x2000
#3548
512 x 480

20 μ m

10kV

15mm

0450



x2000
#3548
512 x 480

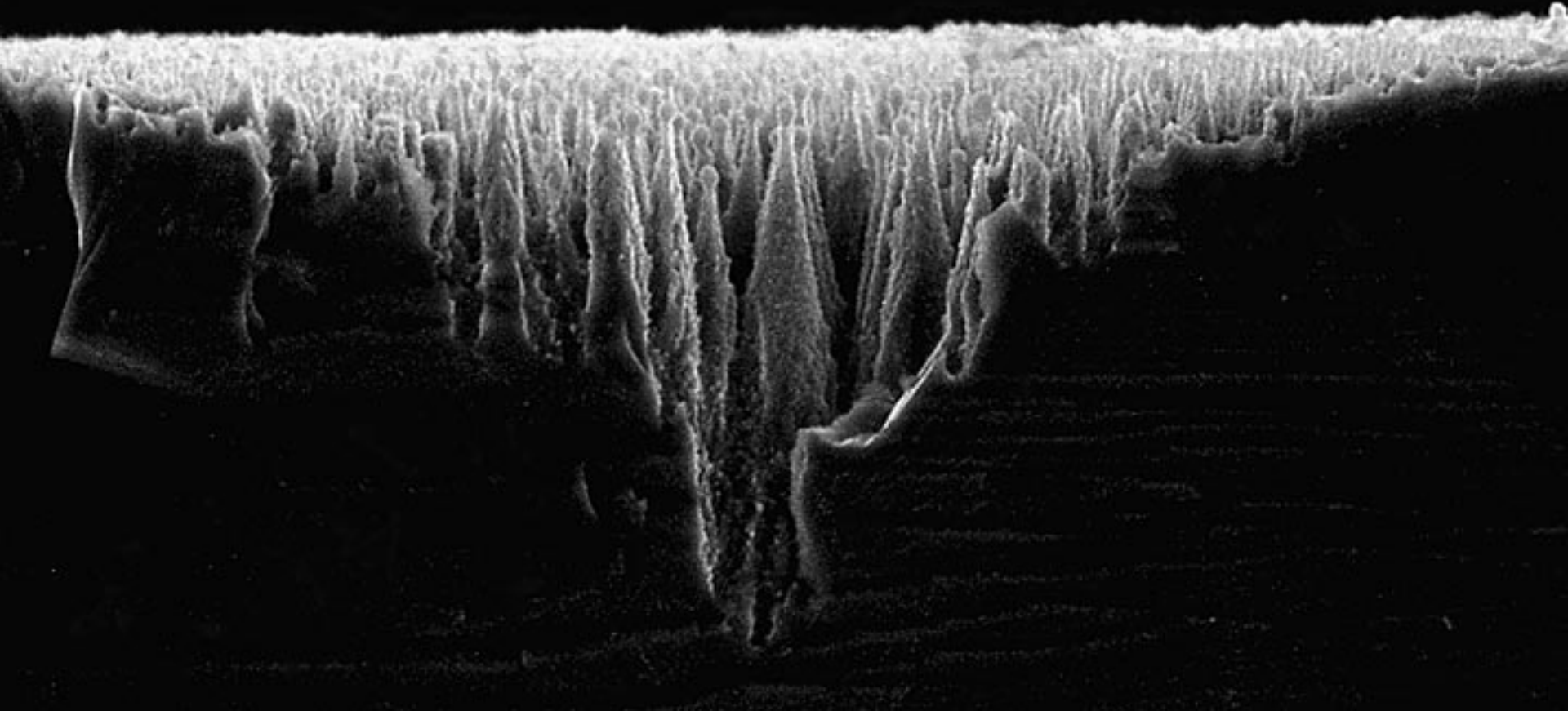
20 μ m

10kV

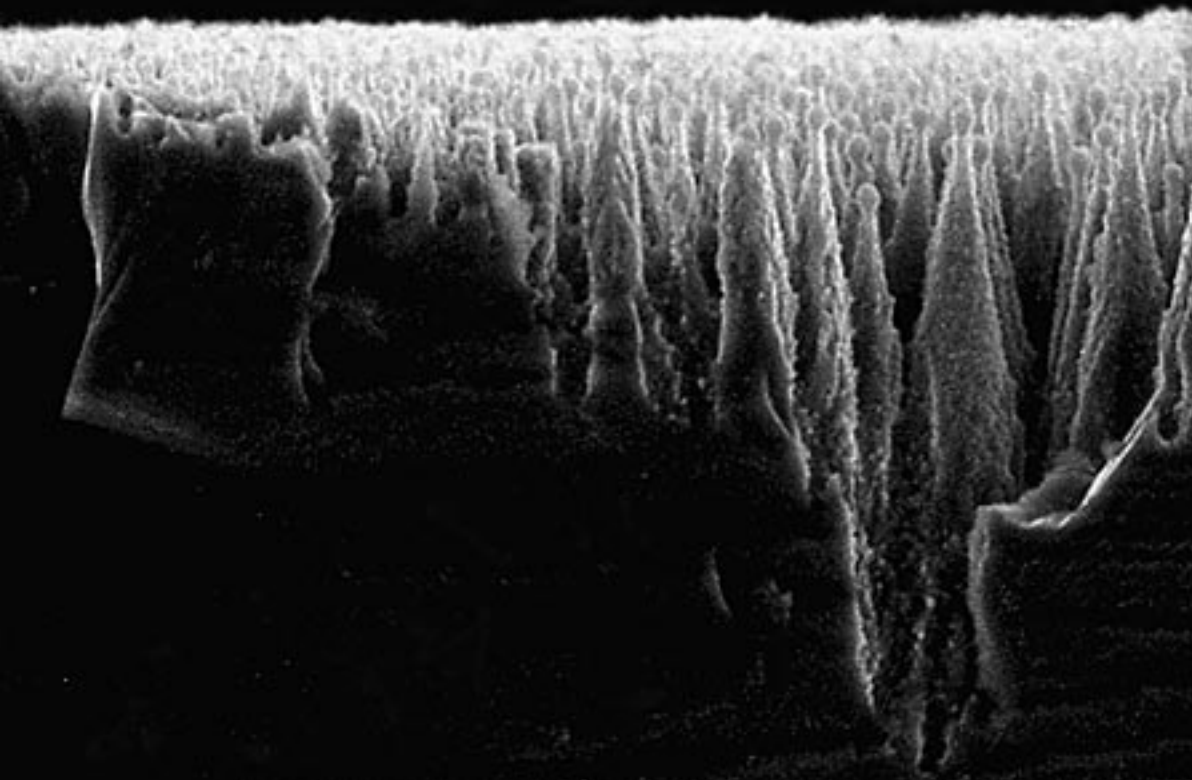
15mm

1000

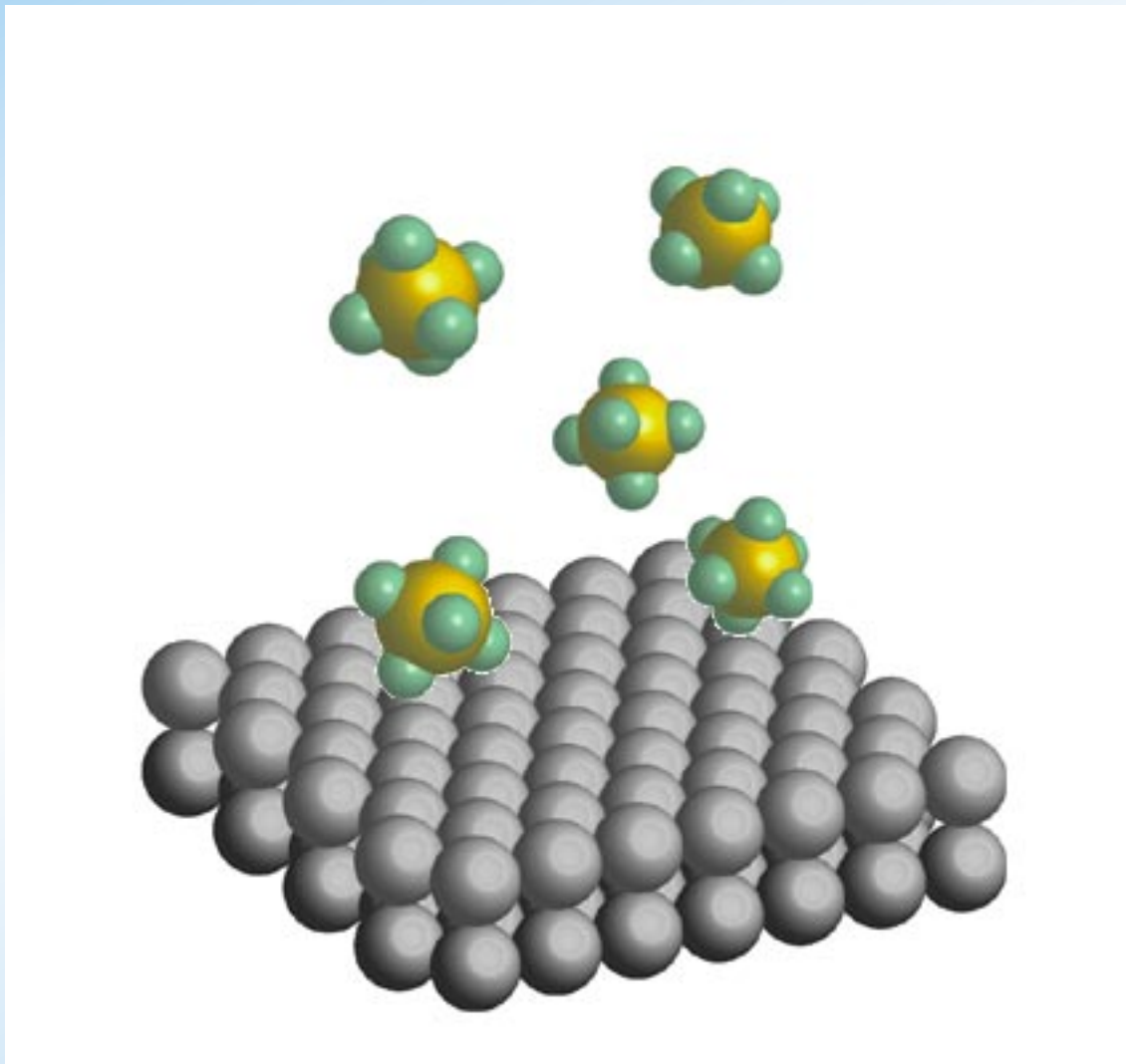
Mechanism



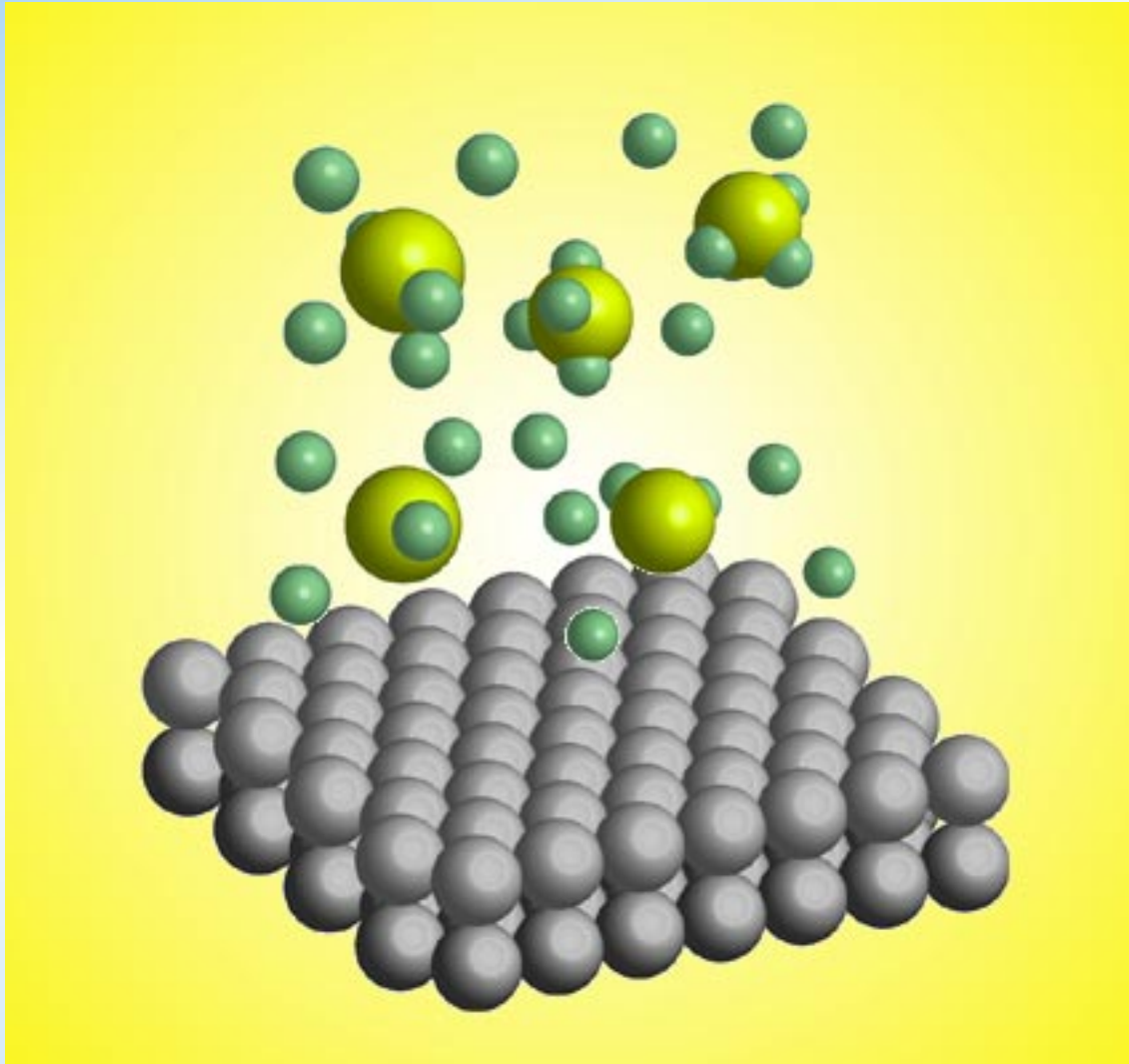
Mechanism



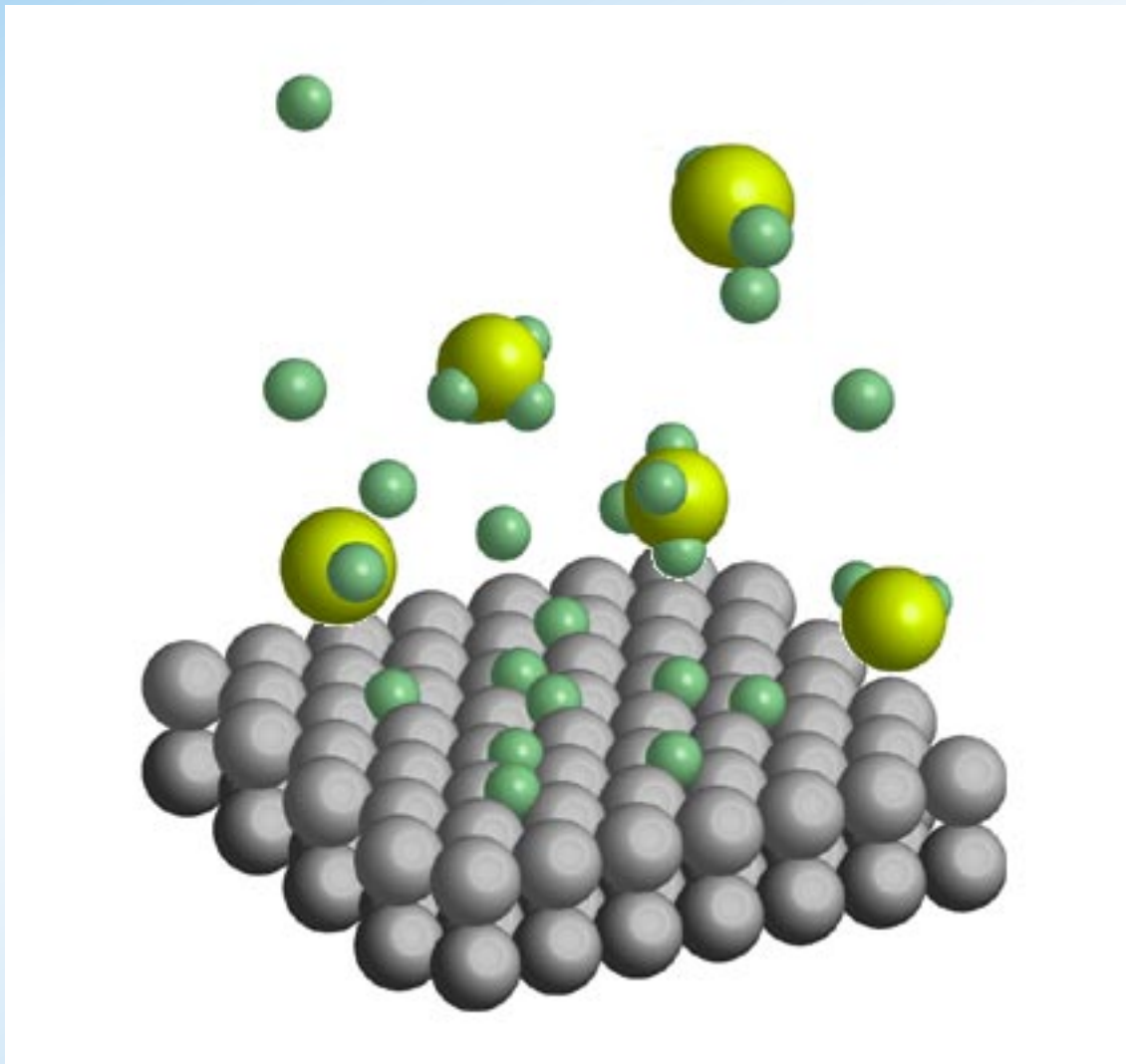
Mechanism



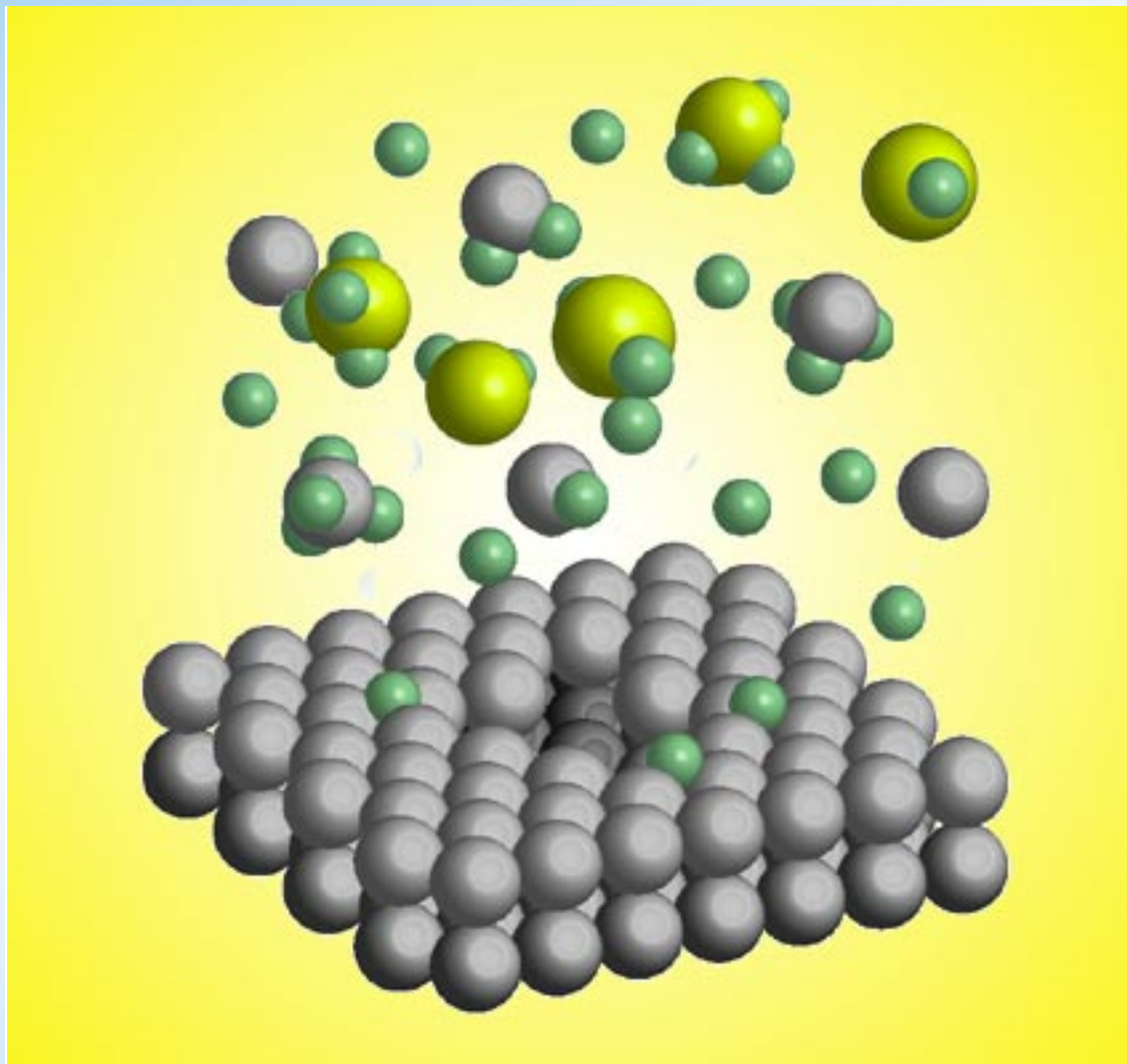
Mechanism



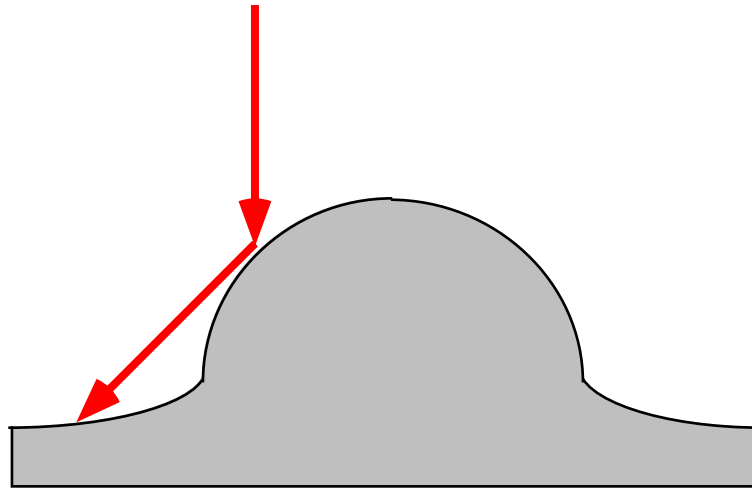
Mechanism



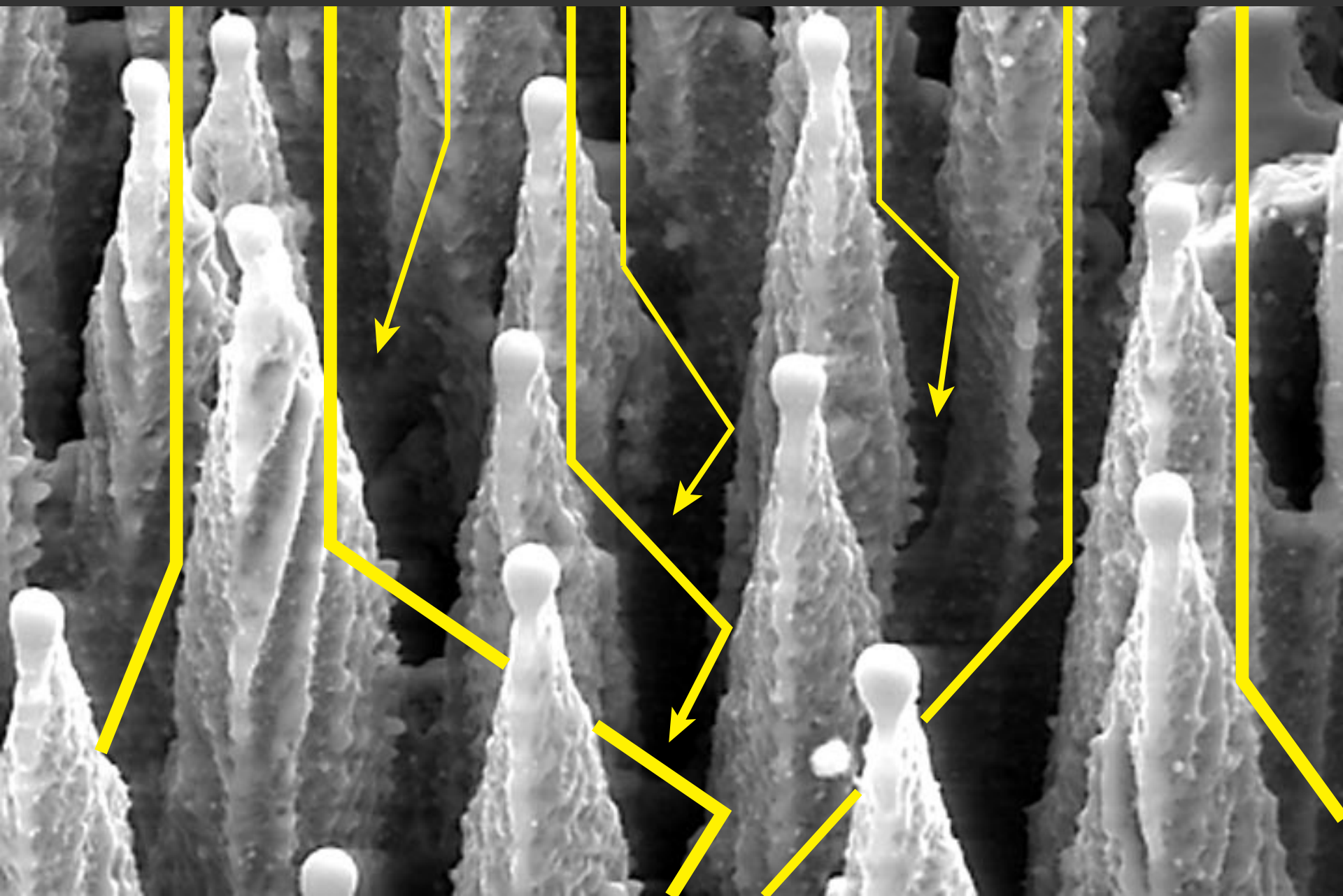
Mechanism



Mechanism

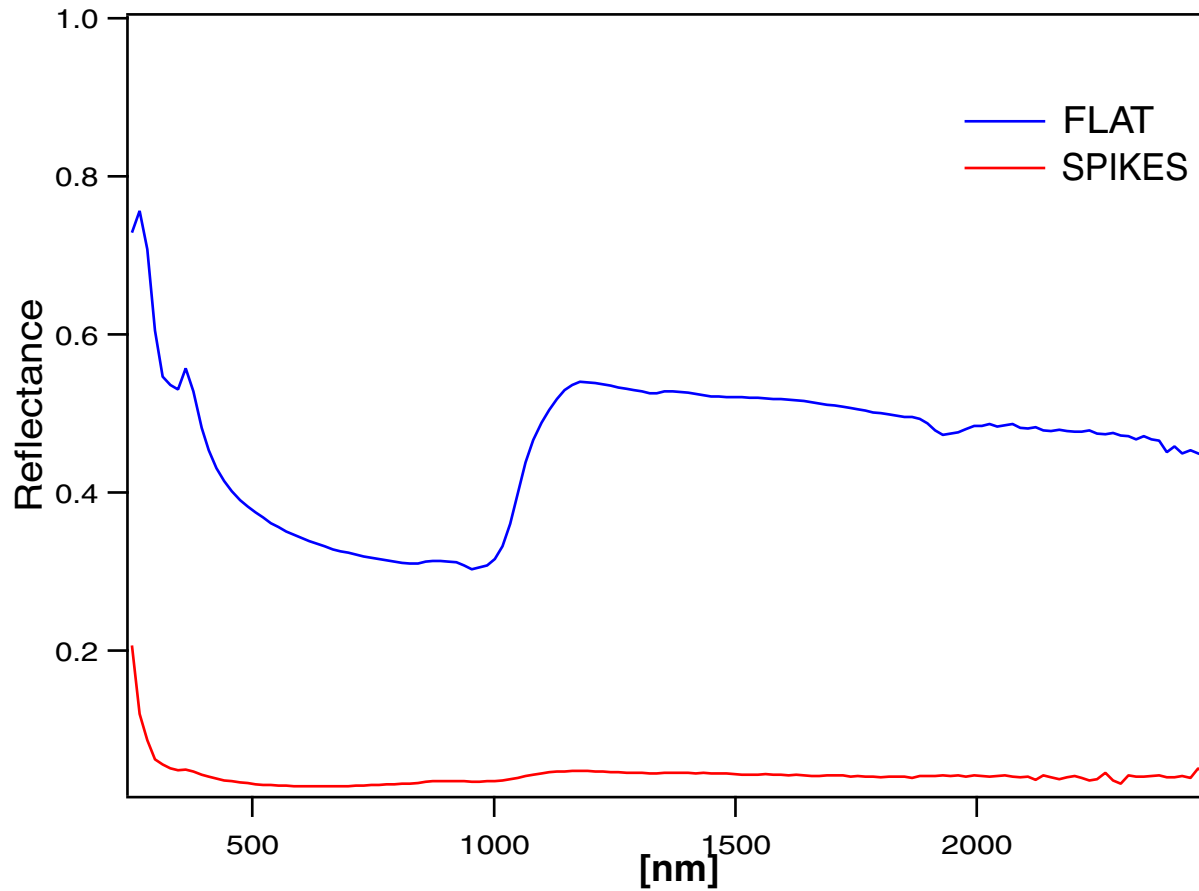


Light absorption



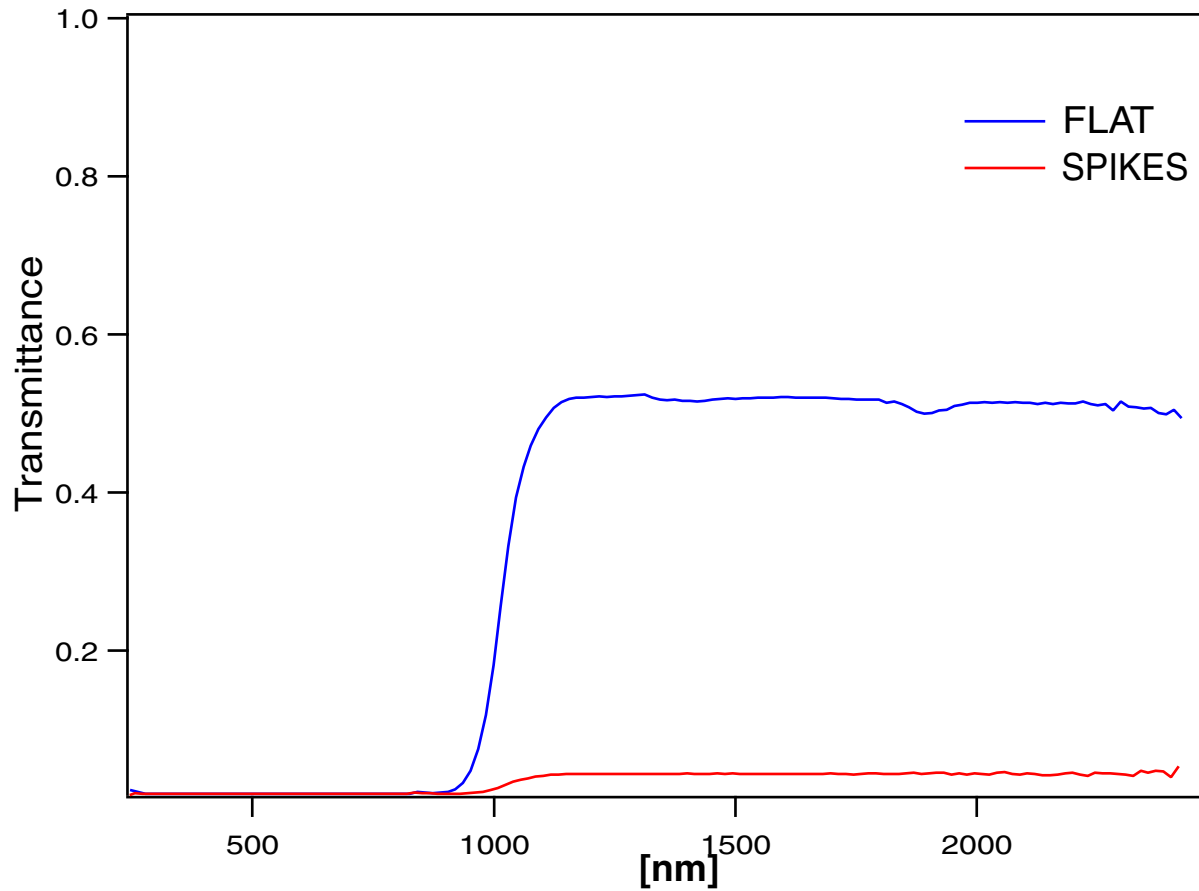
Light absorption

Total reflectance

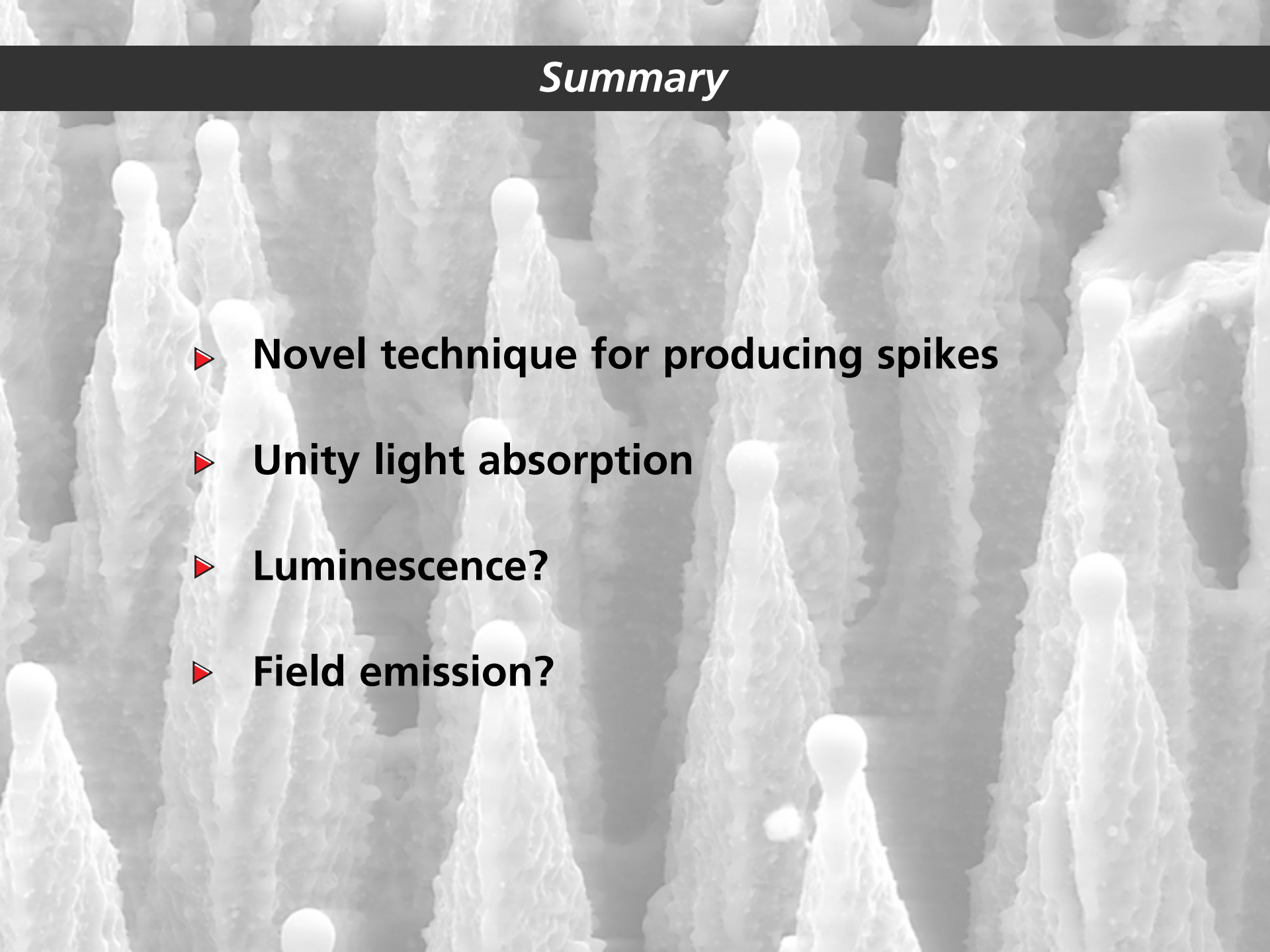


Light absorption

Total transmittance



Summary

- 
- A scanning electron micrograph (SEM) showing a surface covered with many sharp, vertical, conical spikes. The spikes vary in height and are densely packed. The background surface has a rough, textured appearance.
- ▶ **Novel technique for producing spikes**
 - ▶ **Unity light absorption**
 - ▶ **Luminescence?**
 - ▶ **Field emission?**

Potential applications

- ▶ **Photovoltaics**
- ▶ **Display technology**
- ▶ **Medicine**

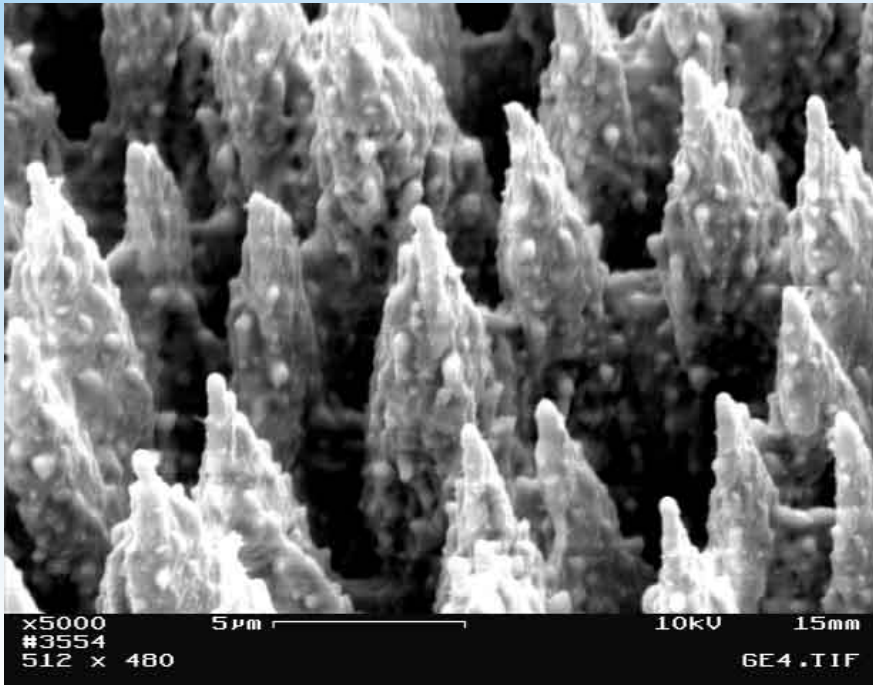


Funding: Army Research Office

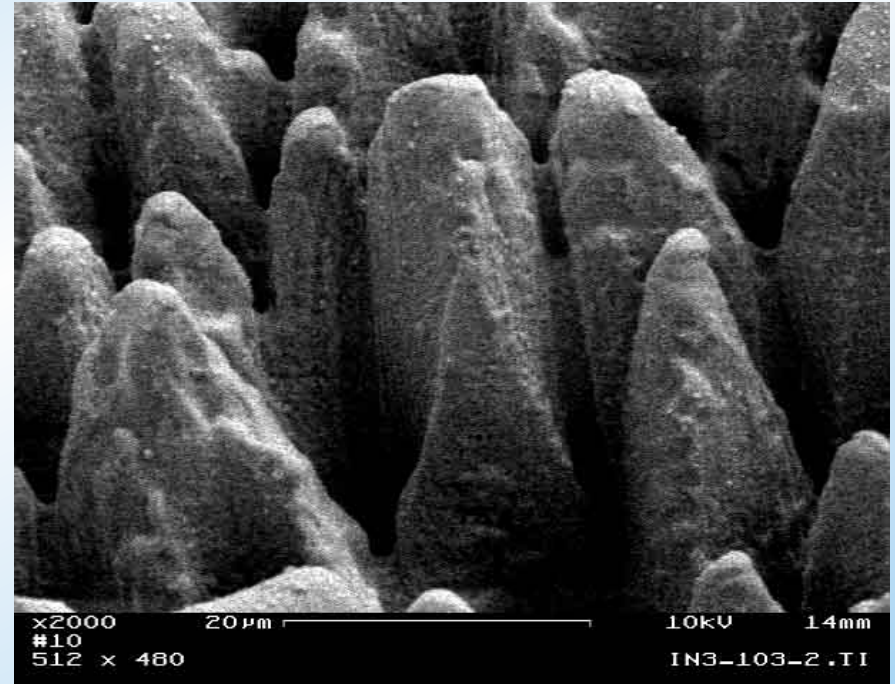
**For a copy of this talk and
additional information, see:**

<http://mazur-www.harvard.edu>

Other materials



Ge



InP