Femtosecond-laser hyperdoping: controlling sulfur concentrations in silicon for band gap engineering

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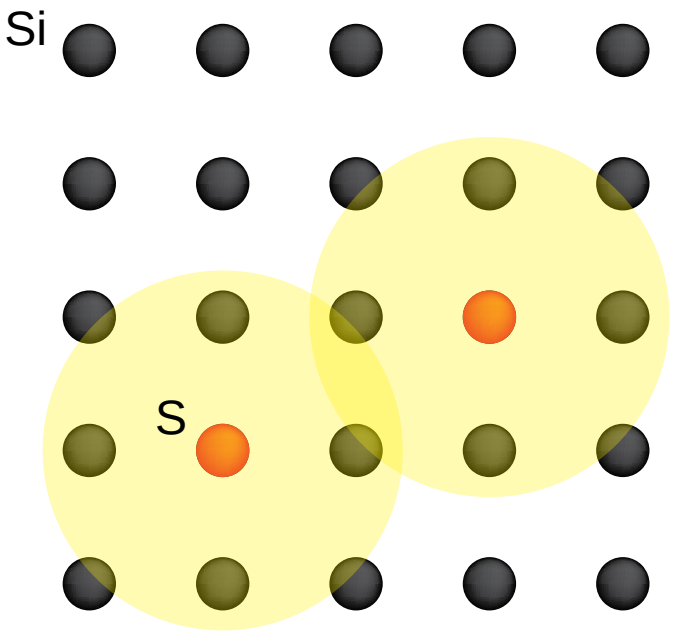
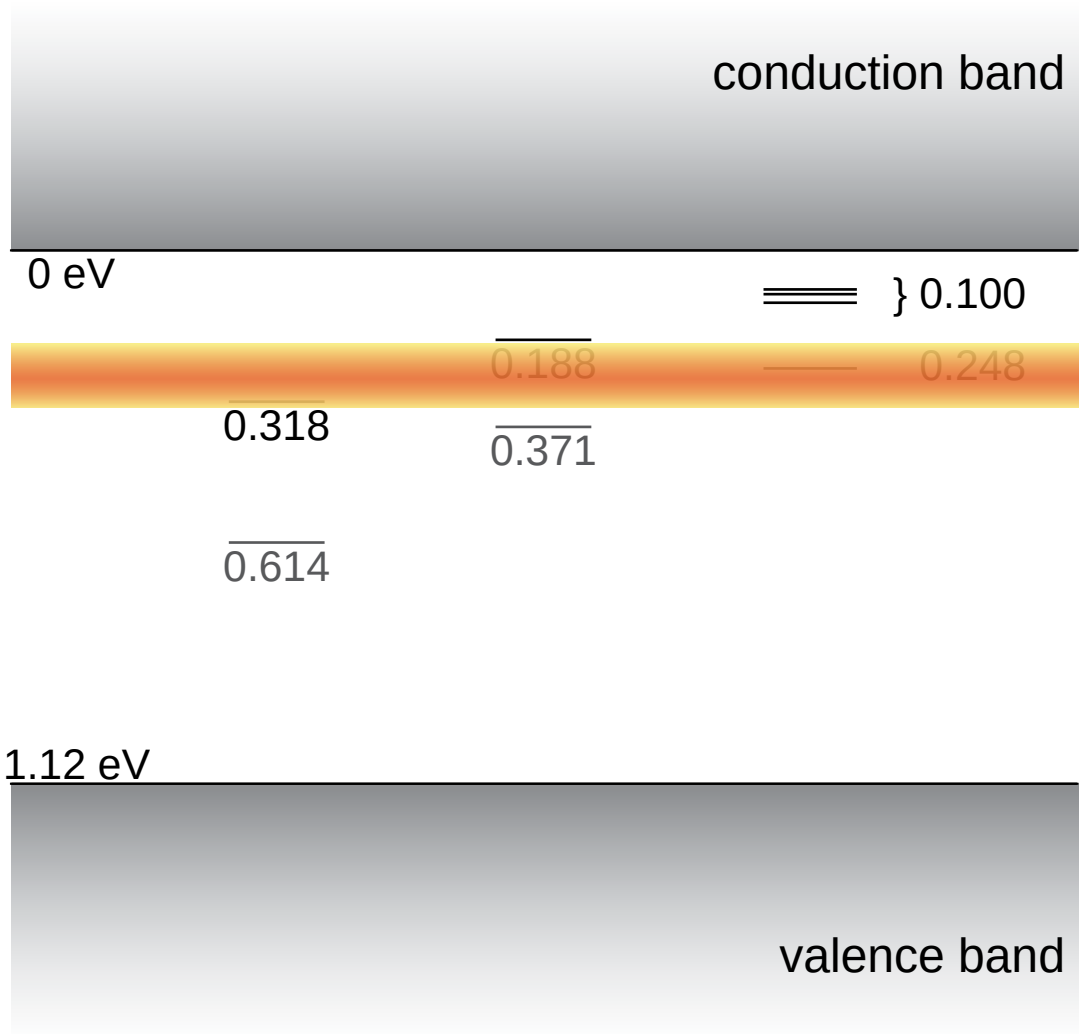
Harvard University
APS March meeting, MA
2012/02/28

Intermediate-band photovoltaics



metal-insulator transition

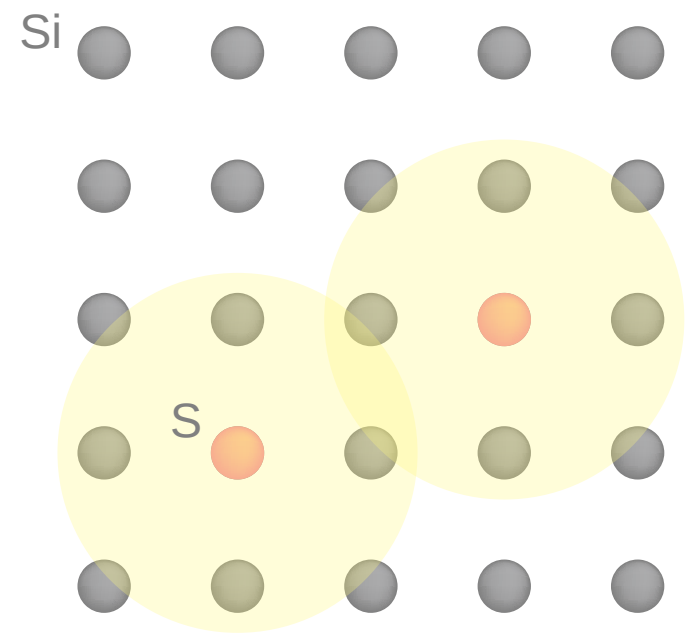


deep level
high concentration

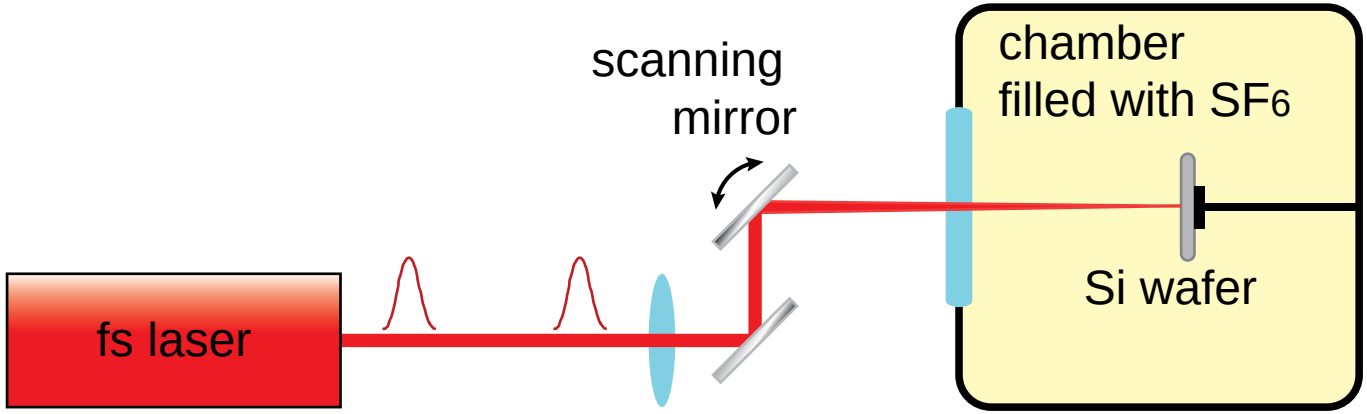
Winkler *et al.*, PRL 106, 178701 (2011)
Ertekin *et al.*, PRL 108, 026401 (2012)

Outline

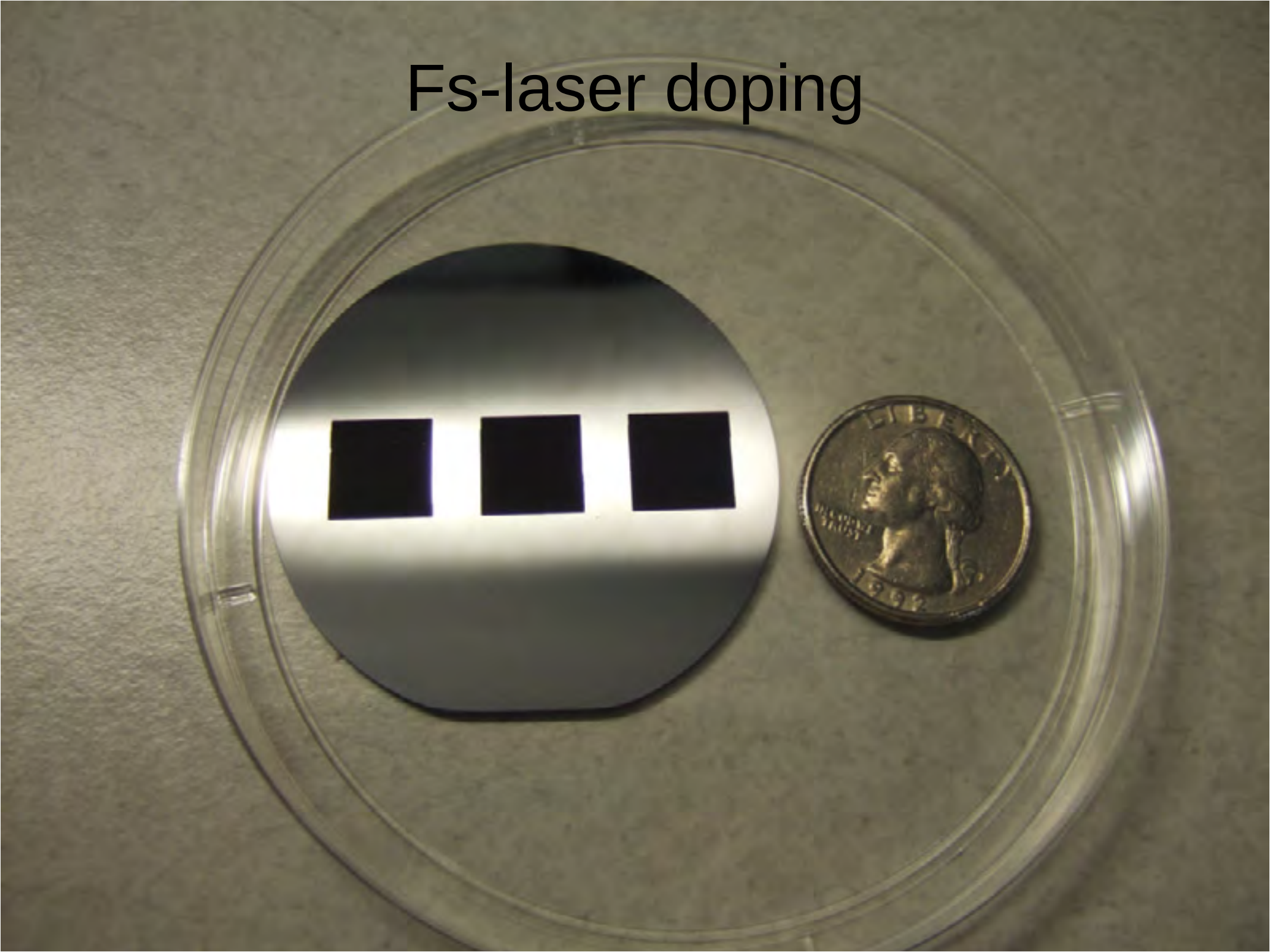
- fs-laser doping
- controlling sulfur concentrations
- optical properties



Fs-laser doping



Fs-laser doping



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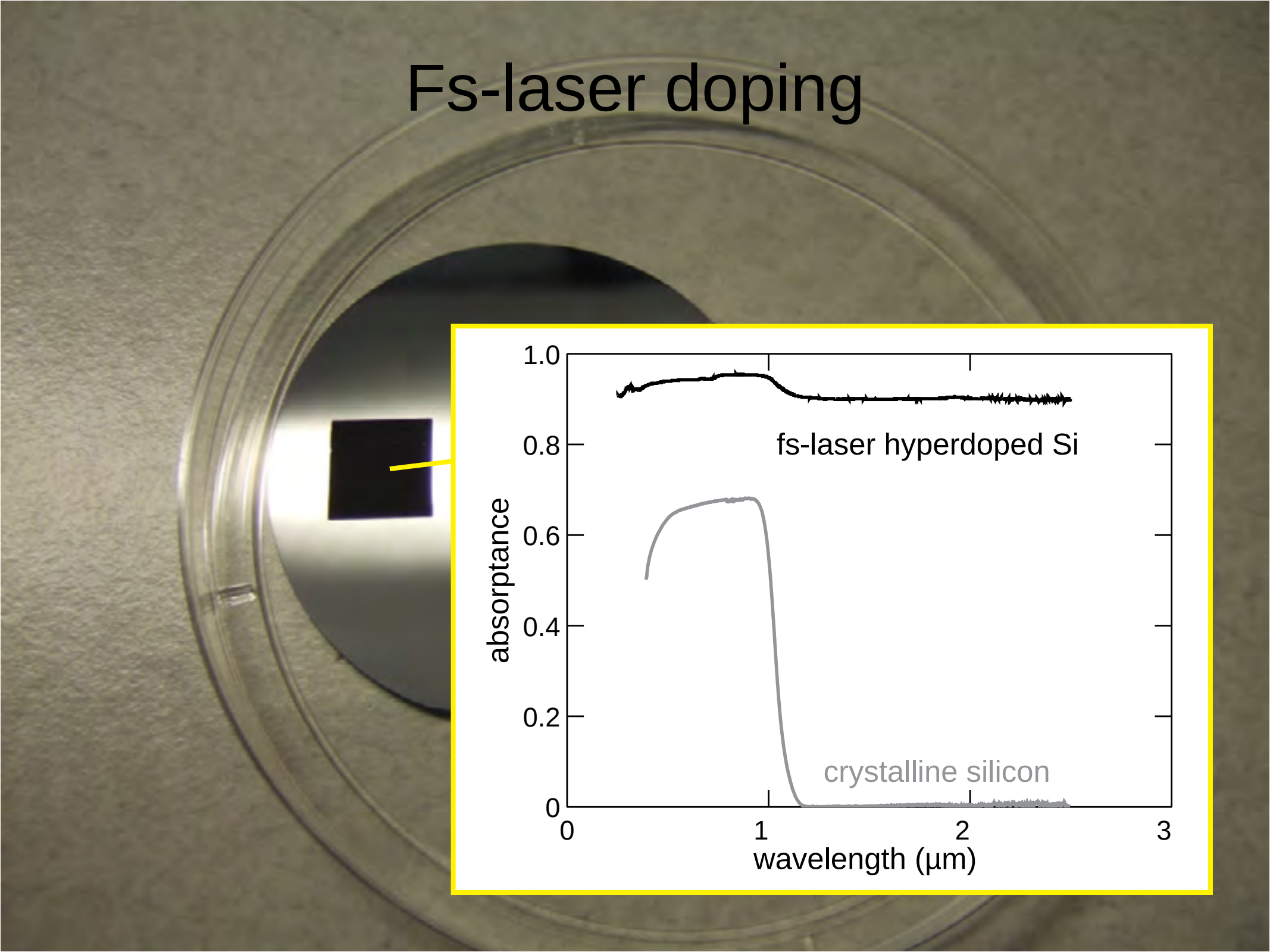

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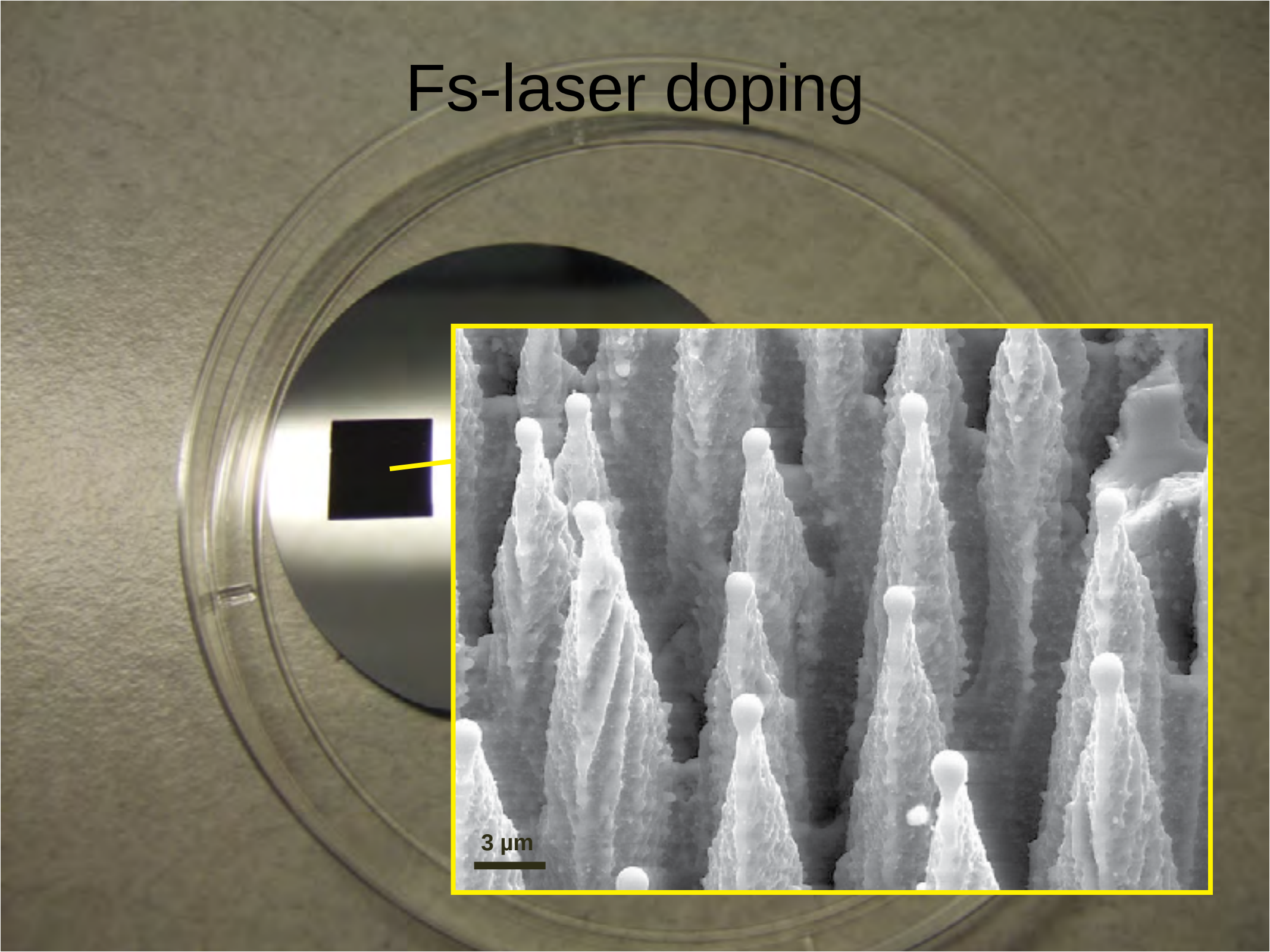

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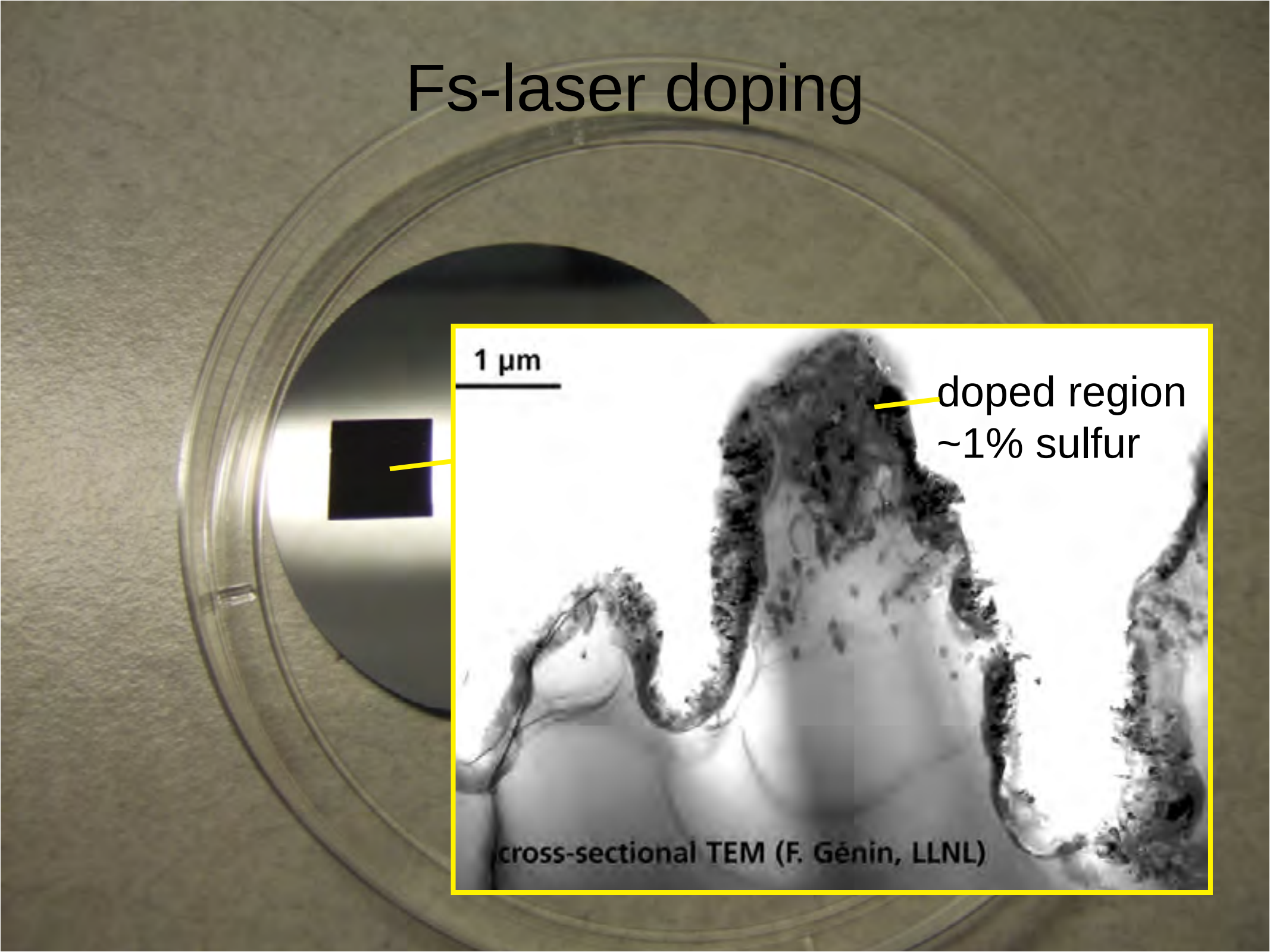

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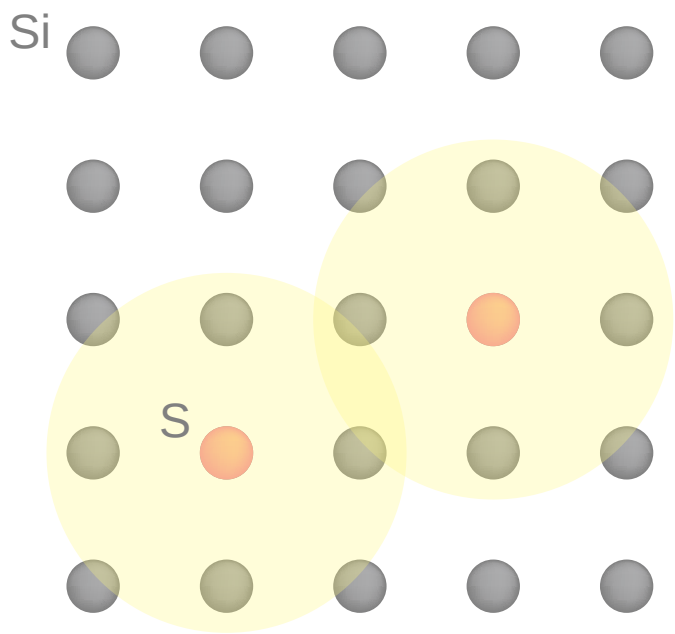
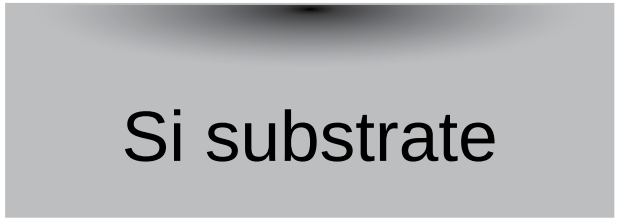
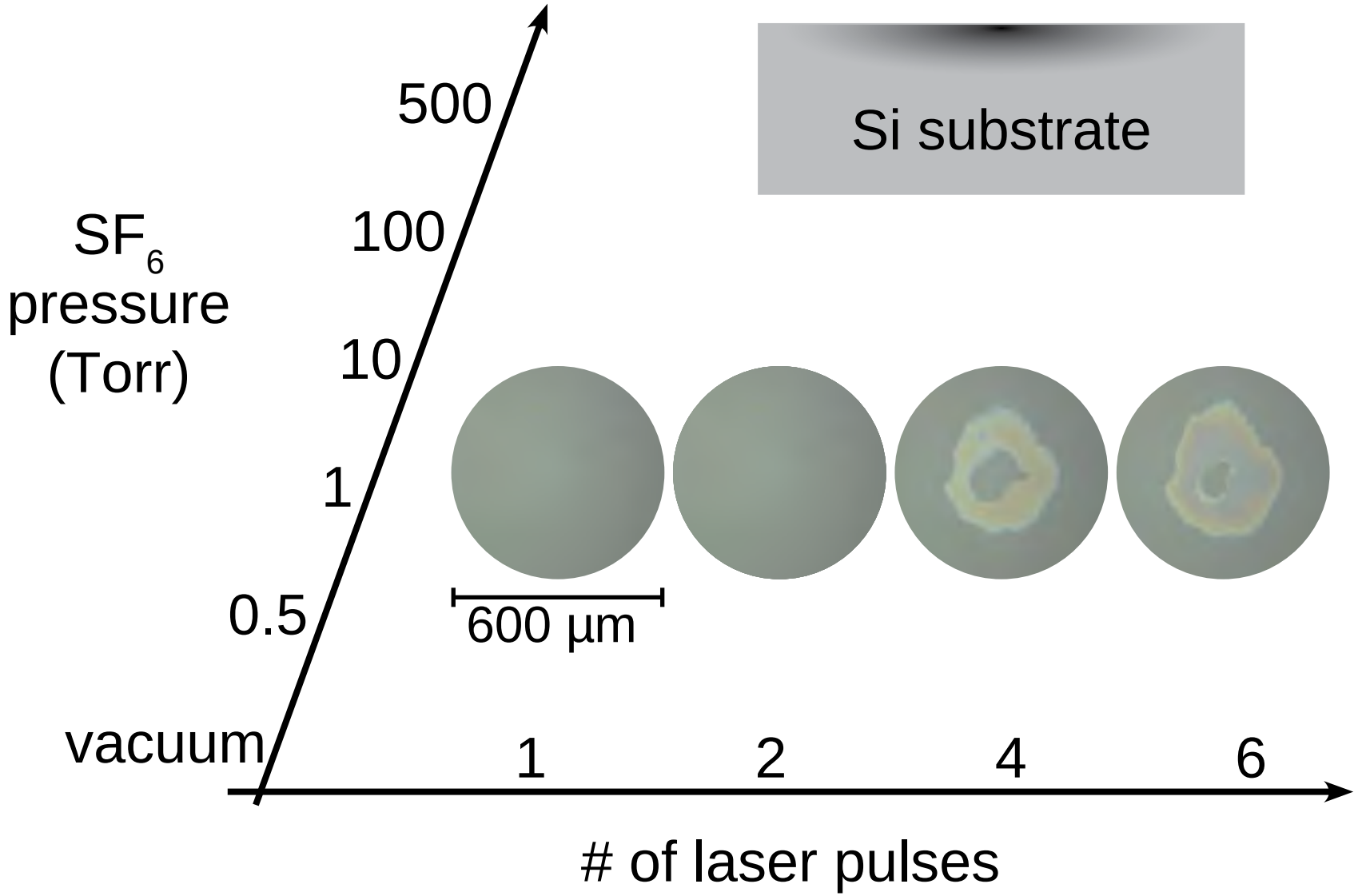


controlling sulfur concentrations

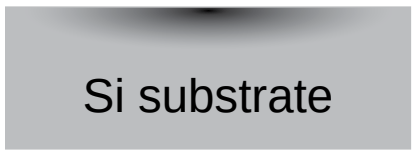


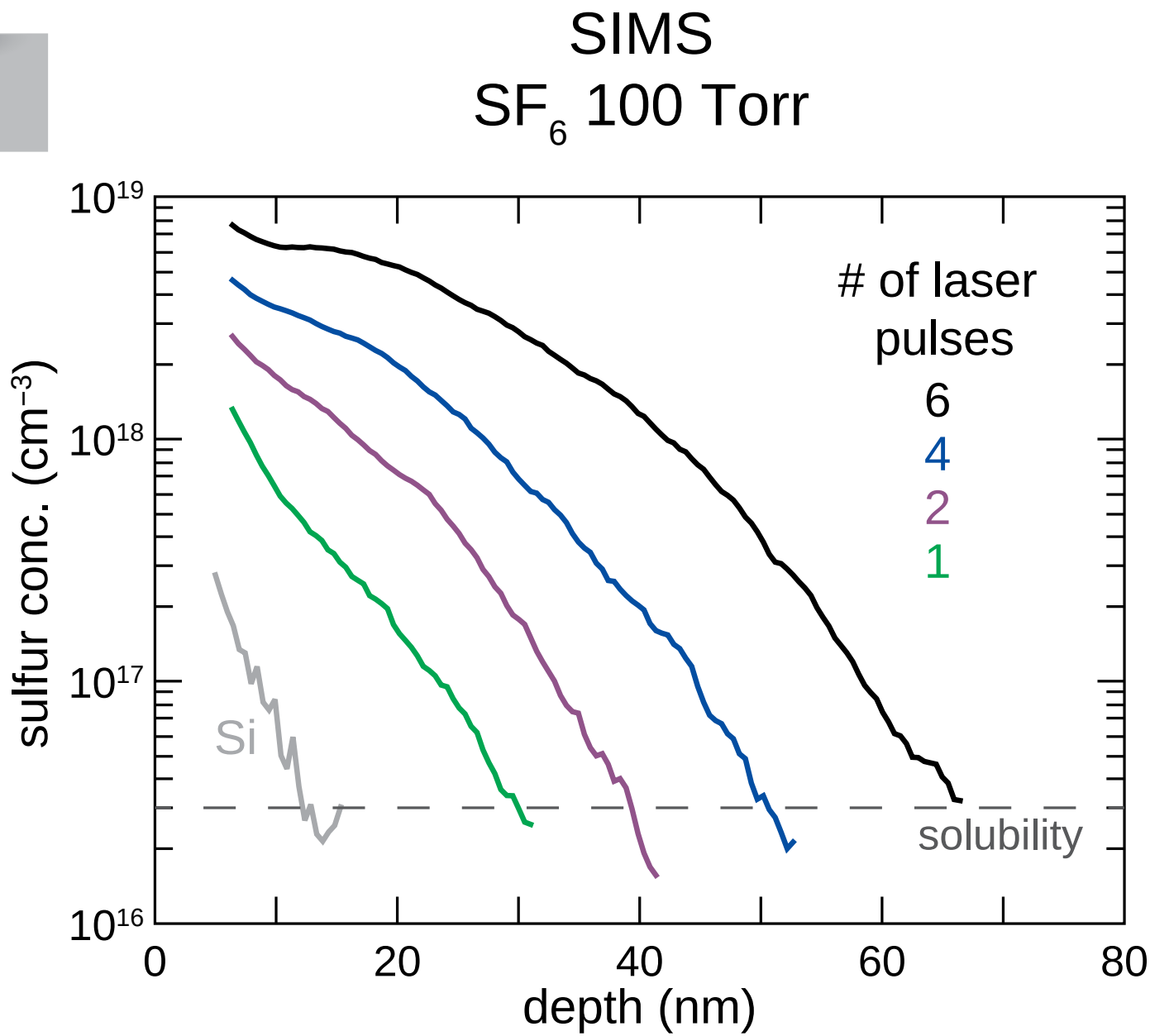
fs-laser: 800 nm, 80 fs, 2.5 kJ/m^2

controlling sulfur concentrations



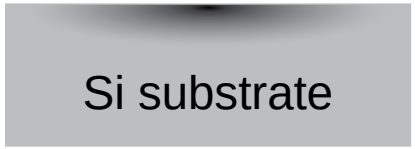
controlling sulfur concentrations



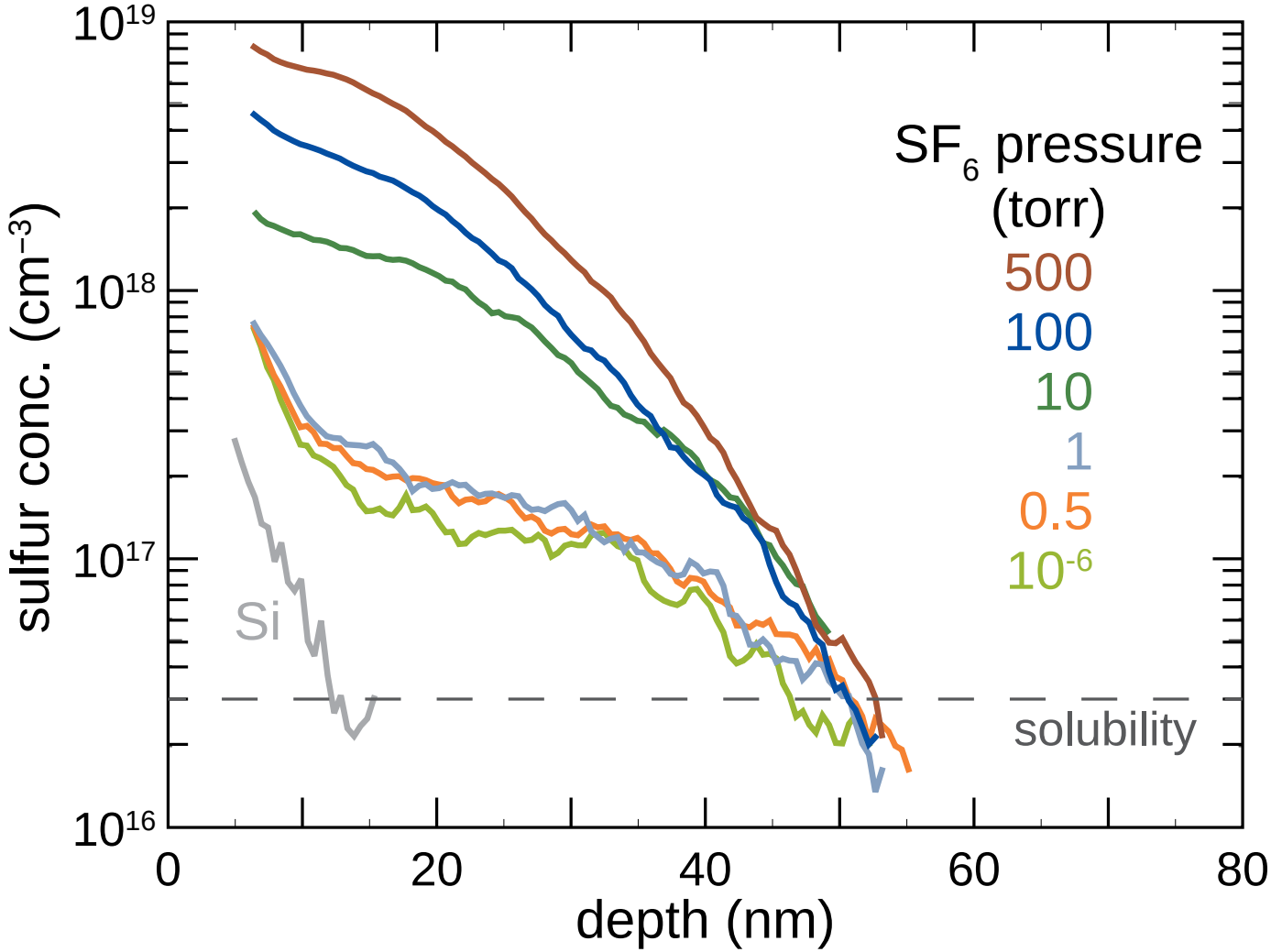


Carlson *et al.*, J. Physics and Chemistry of Solids 8, 81 (1959)

controlling sulfur concentrations



SIMS
4 laser pulses



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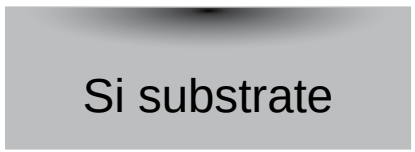
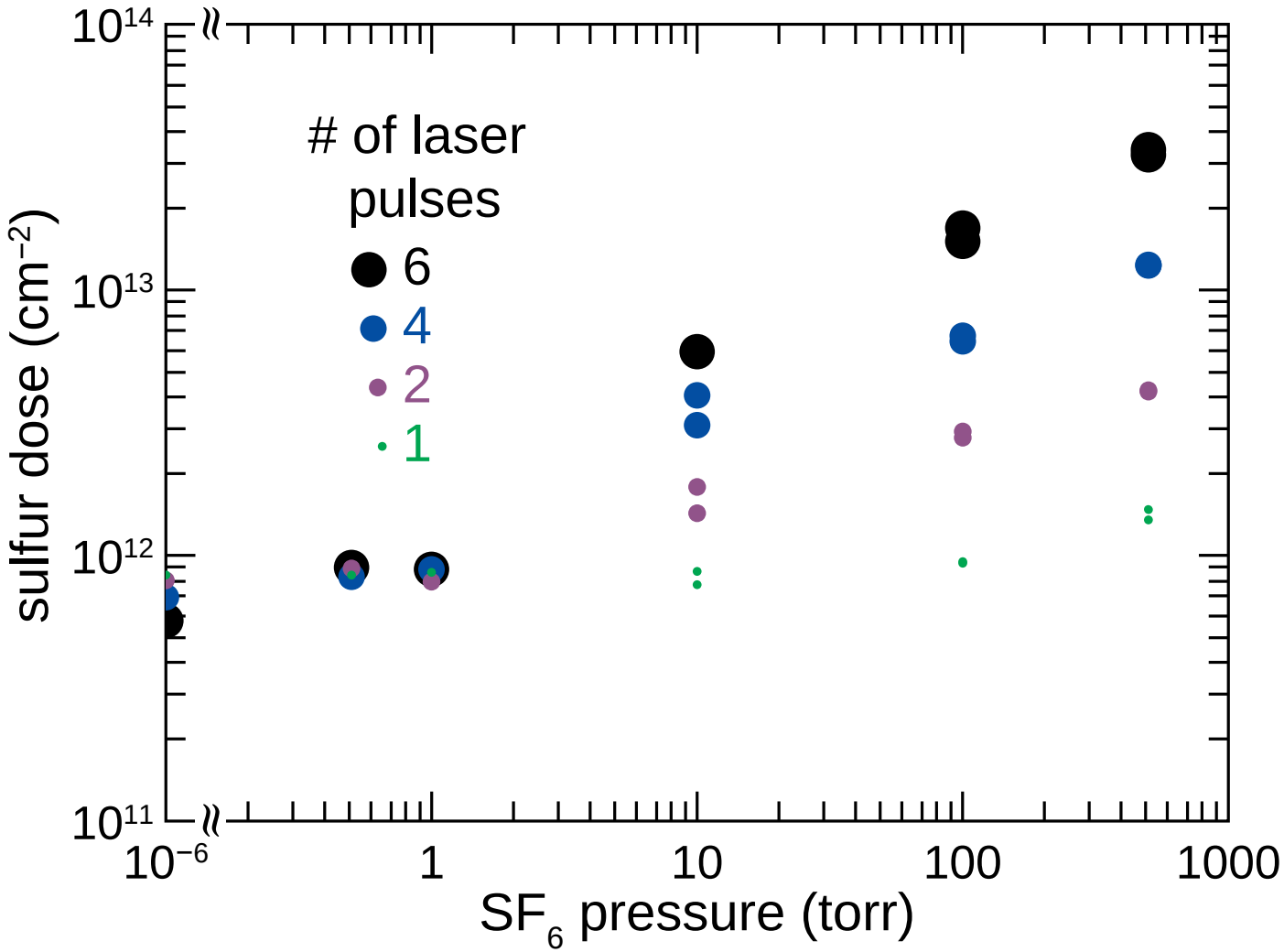
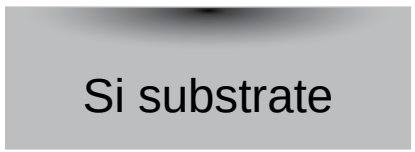


SIMS



controlling sulfur concentrations



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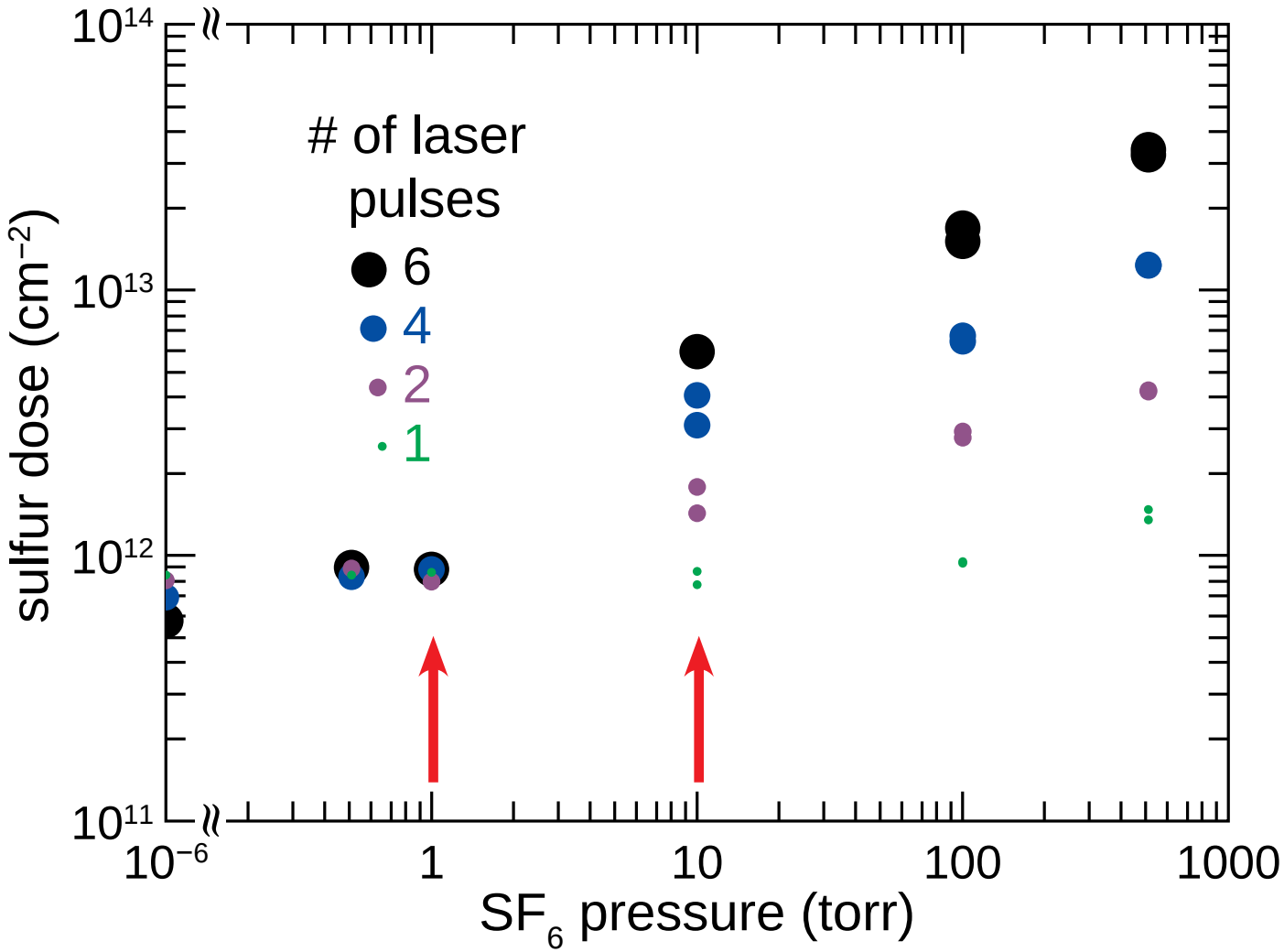

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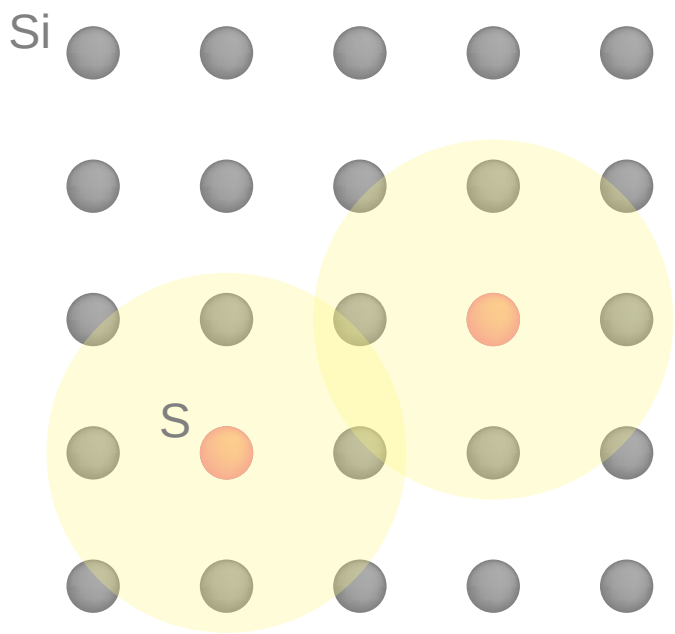
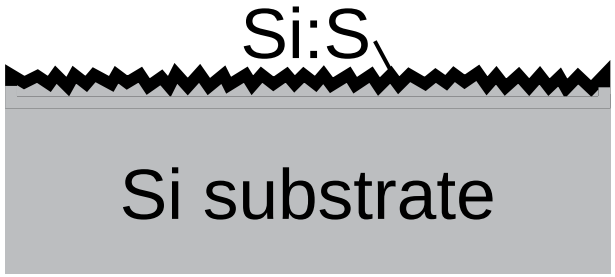
- controlling sulfur concentrations
- optical properties

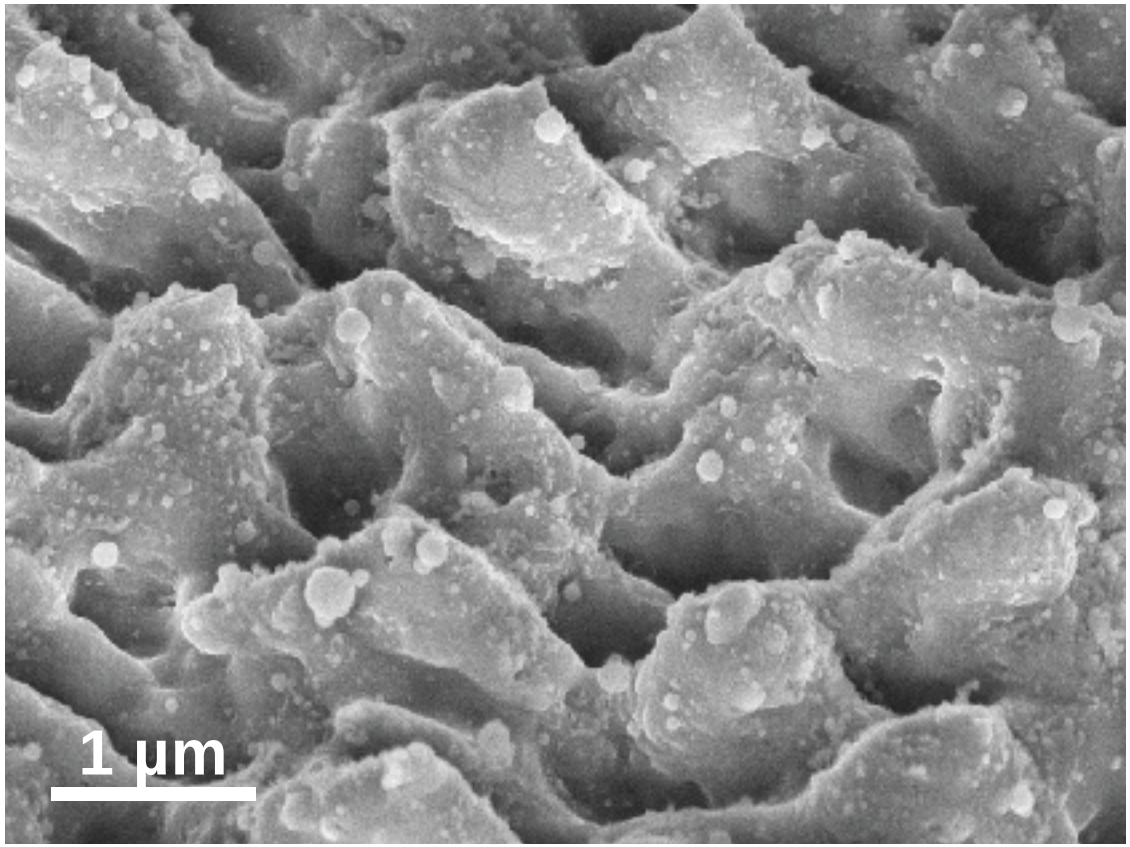


Optical properties

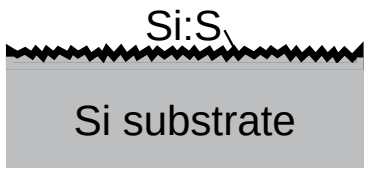
fs-laser: 2.5 kJ/m^2 50 pulses
SF_6 1 &10 Torr



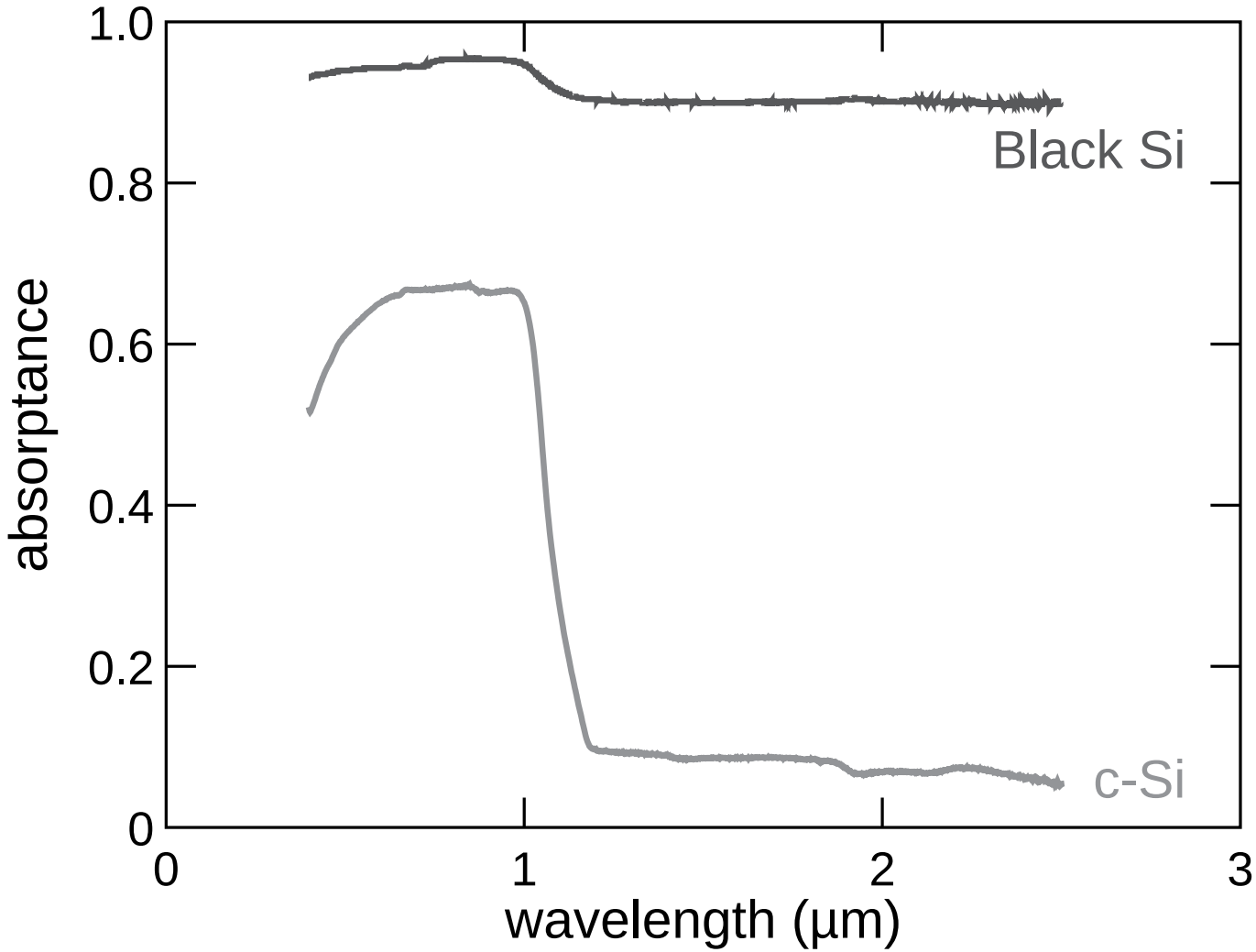
45° SEM



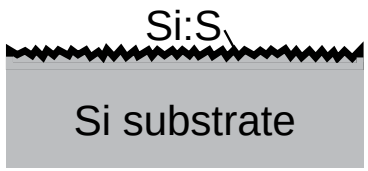
Optical properties



$$A = 1 - T_{int} - R_{int}$$



Optical properties



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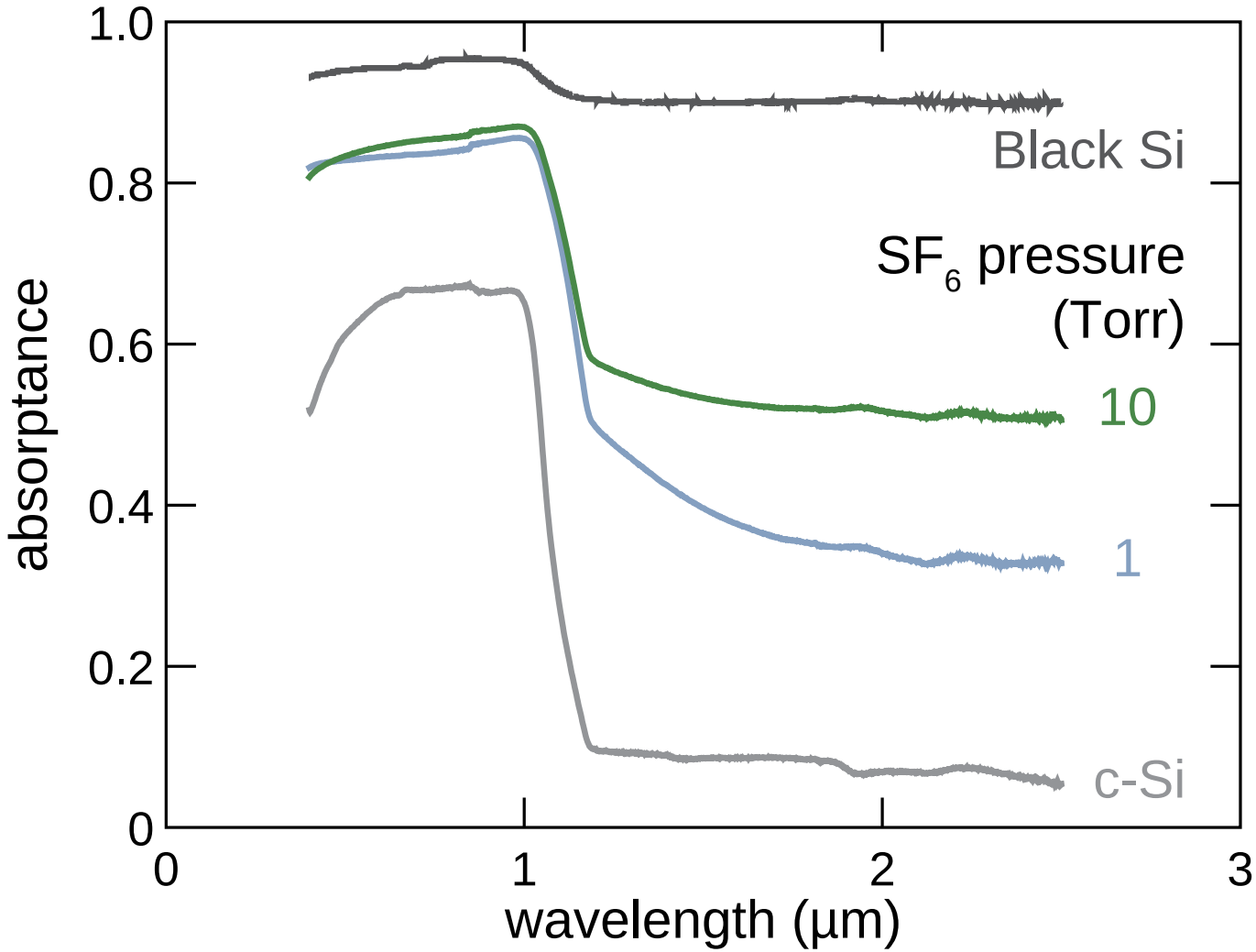
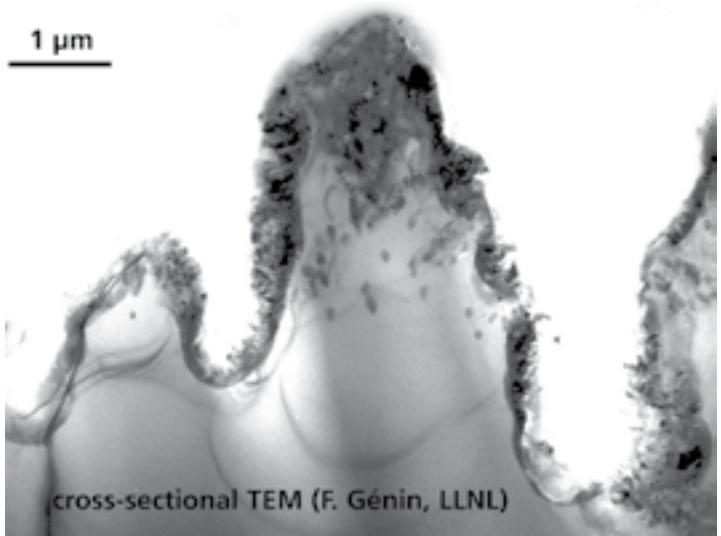
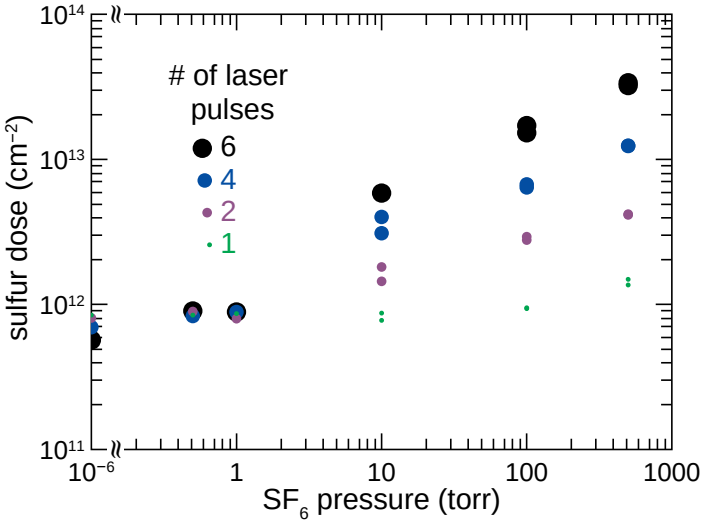
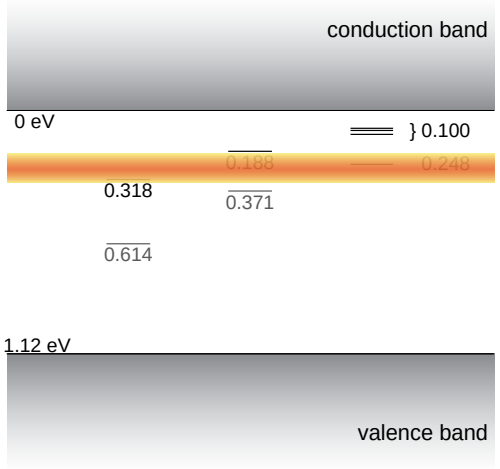


Conclusions

- Fs-laser doping
  - light trapping surfaces
  - non-equilibrium concentrations of S in Si
- Identify parameters for controlling dopant incorporation
  - non-linear response in pressure and # of laser pulses
- IR absorption correlates with pressure of the dopant precursor







Thanks!

Questions?

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Center for Nanoscale Systems

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