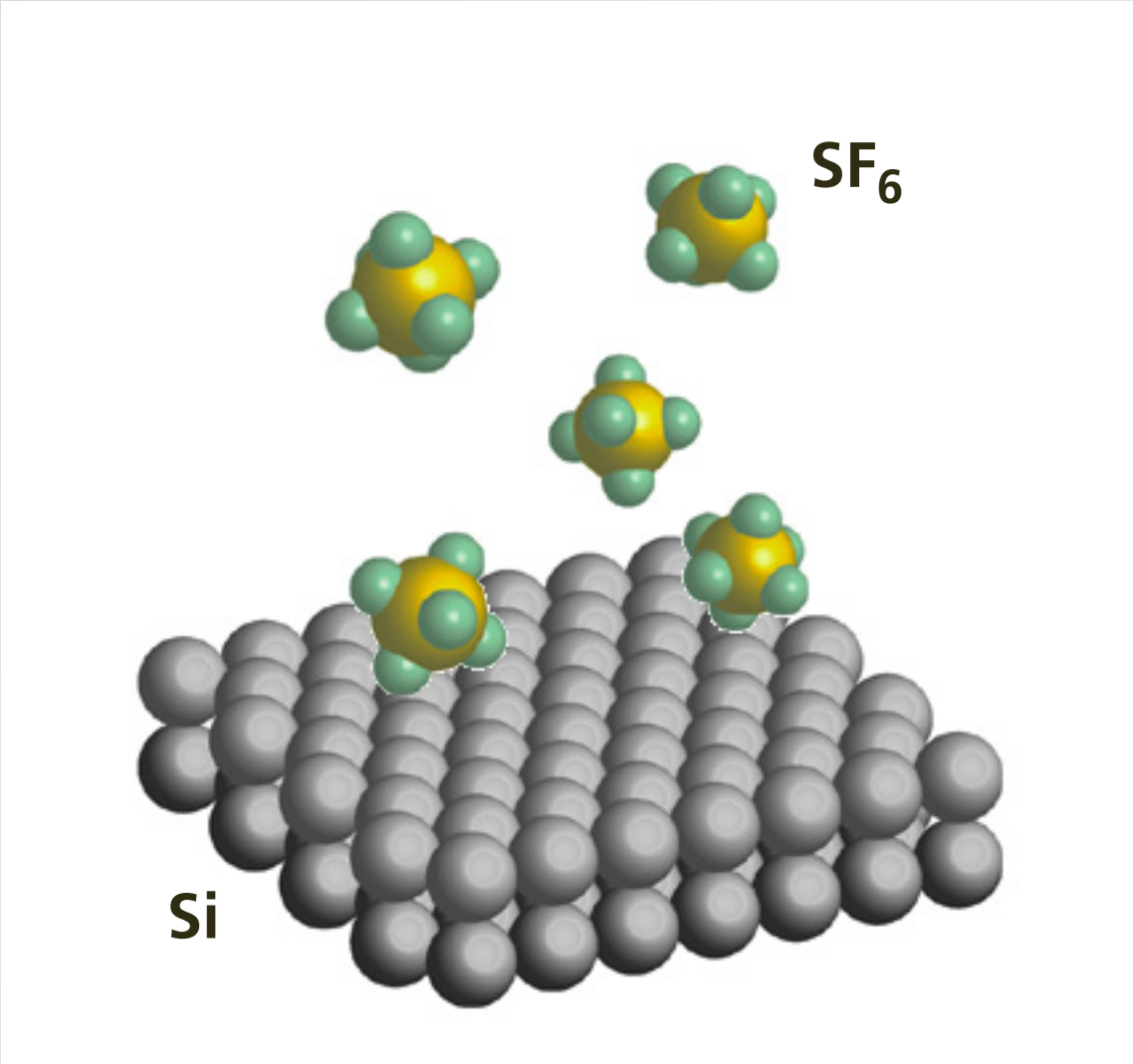
Black silicon: better photovoltaics?

Harvard Energy Innovation Showcase
Harvard University
Cambridge, MA, 29 November 2011

Introduction

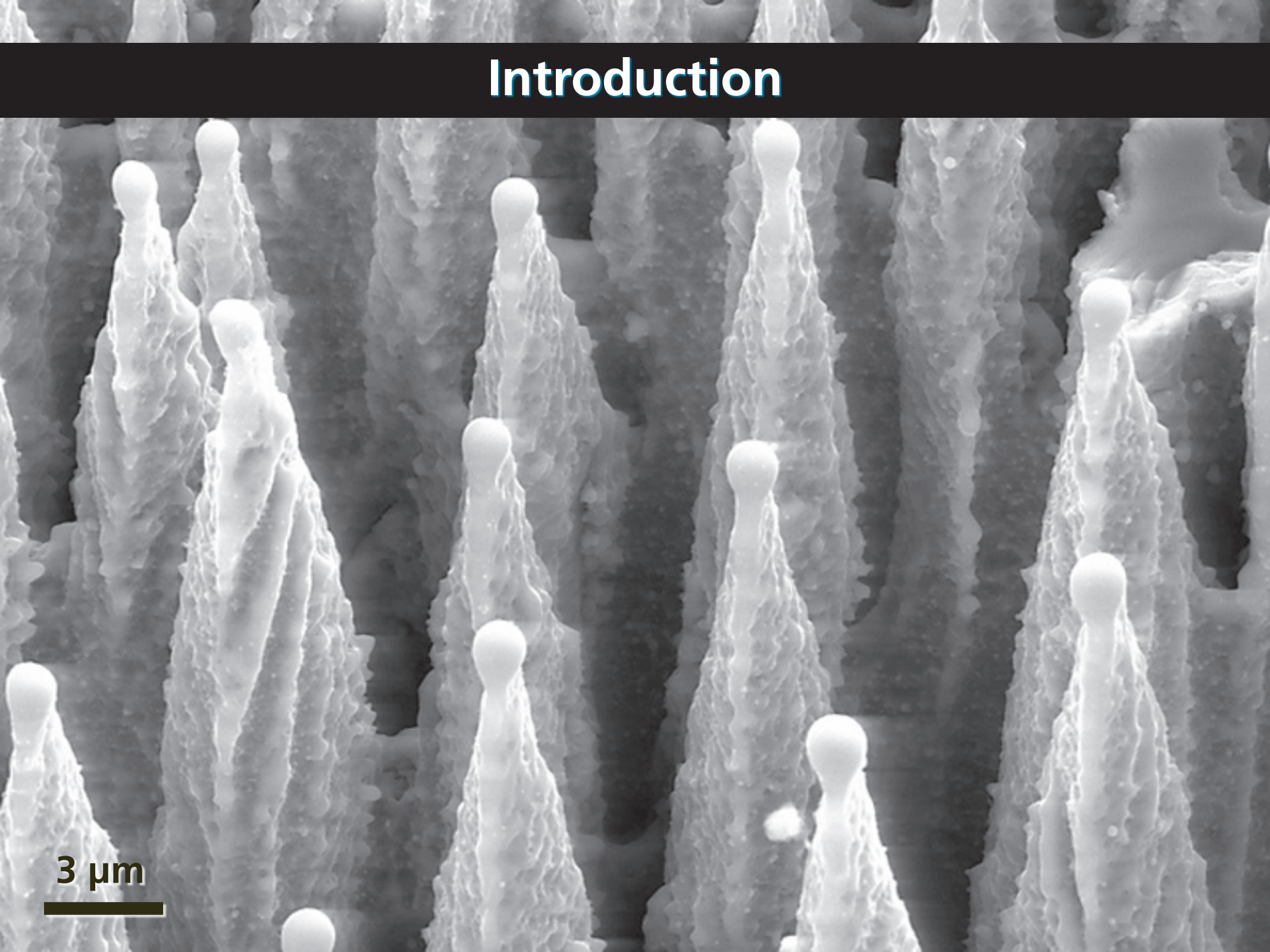


irradiate with 100-fs 10 kJ/m^2 pulses

Introduction

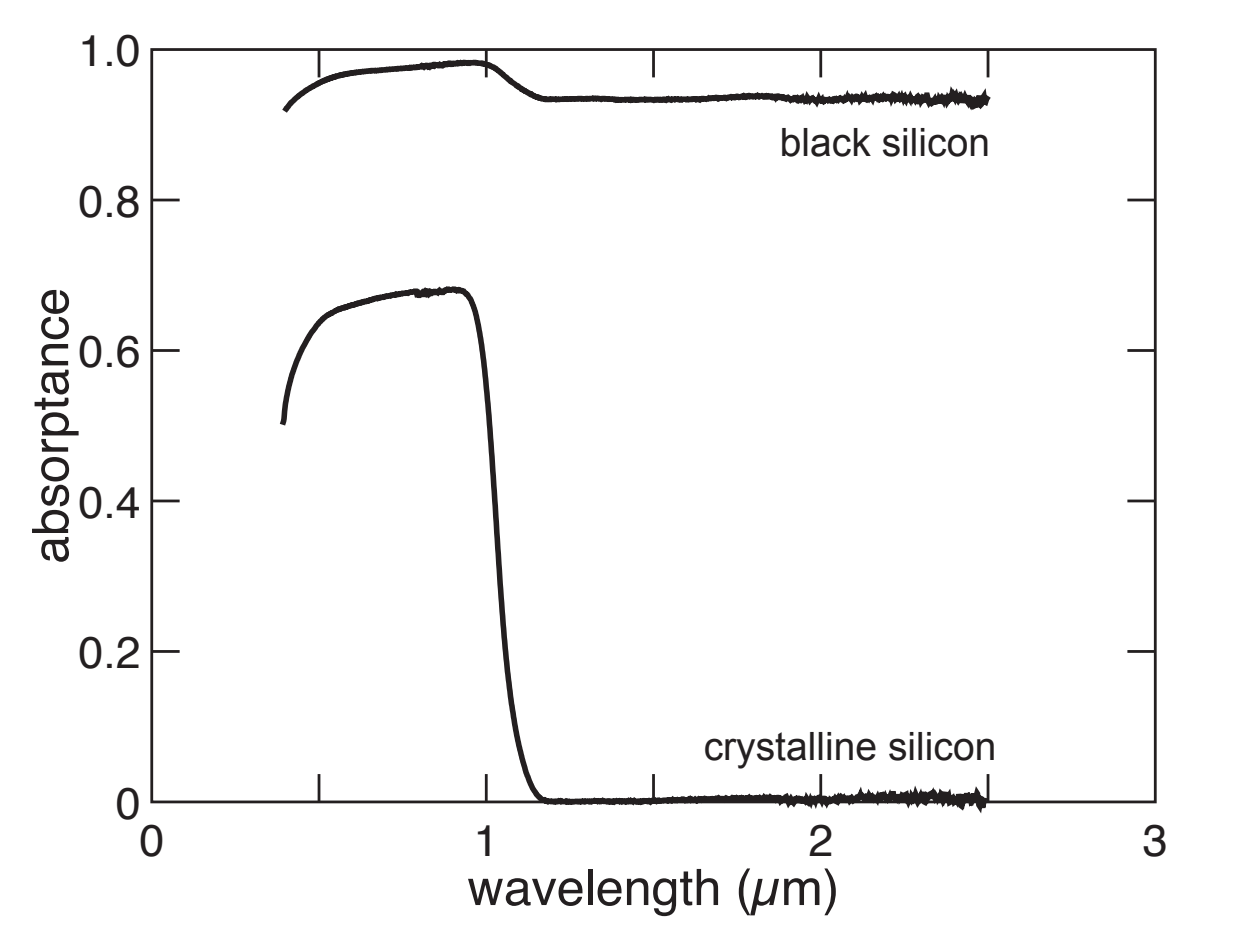
“black silicon”

Introduction

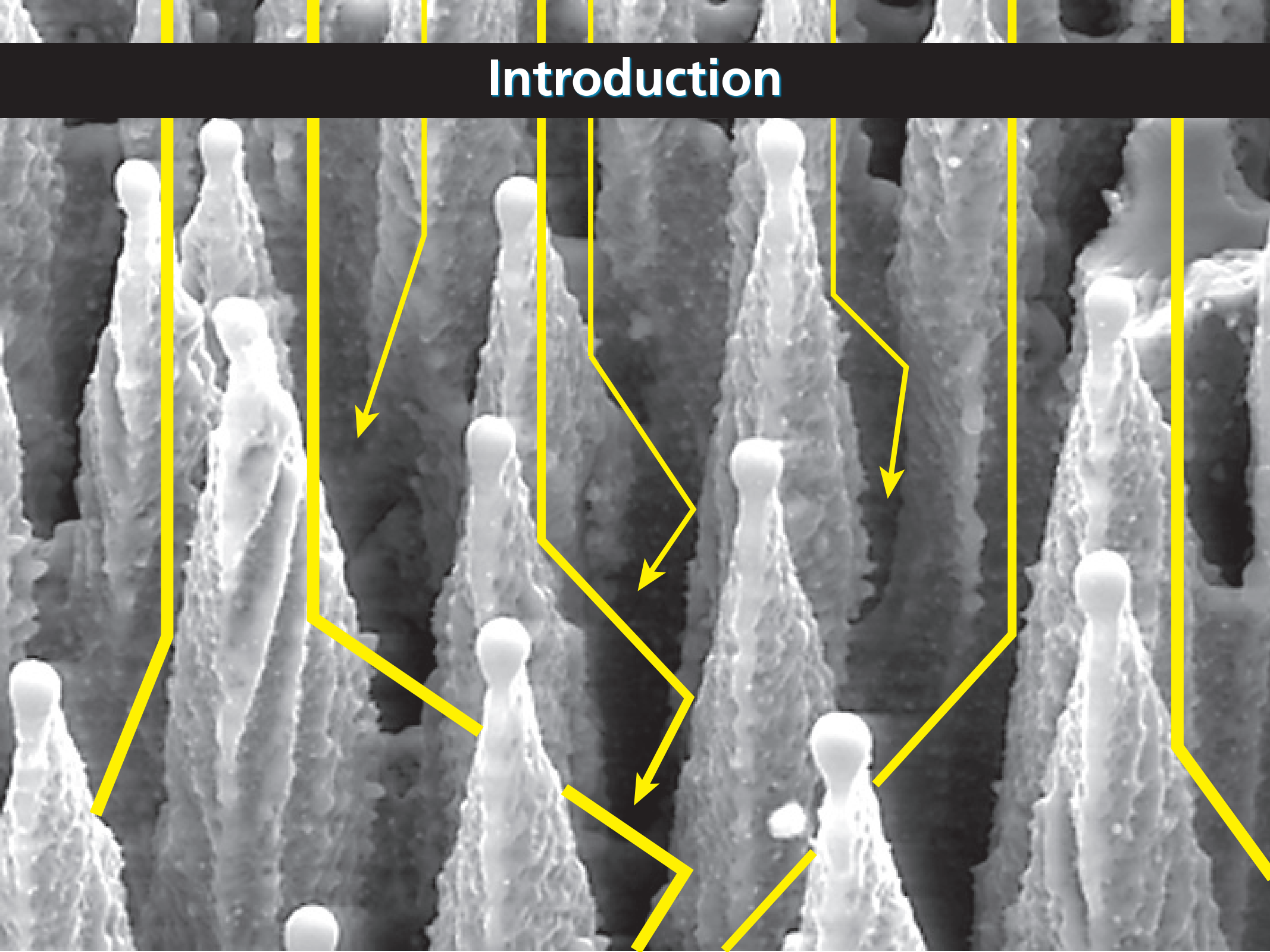


Introduction

absorptance ($1 - R_{int} - T_{int}$)

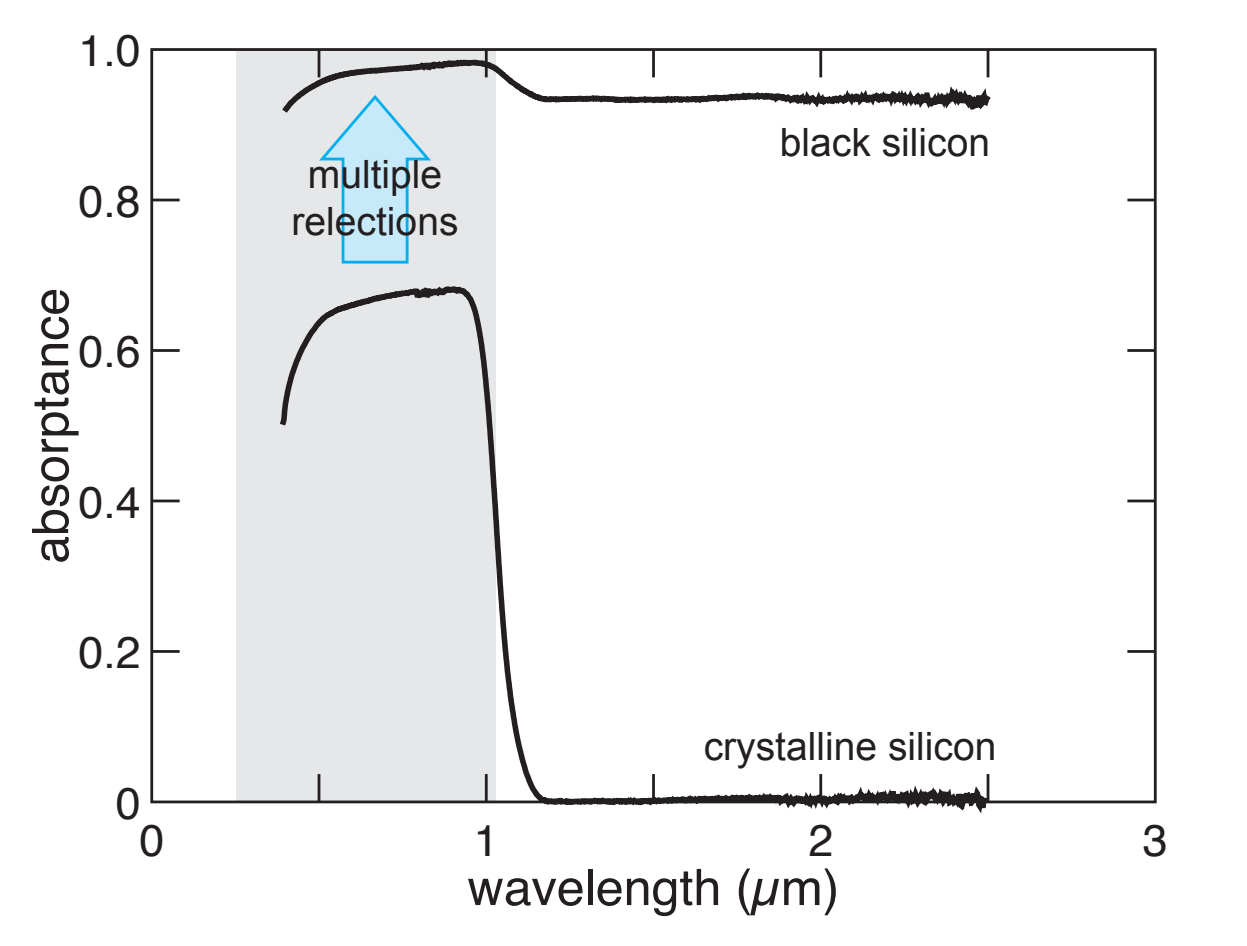


Introduction

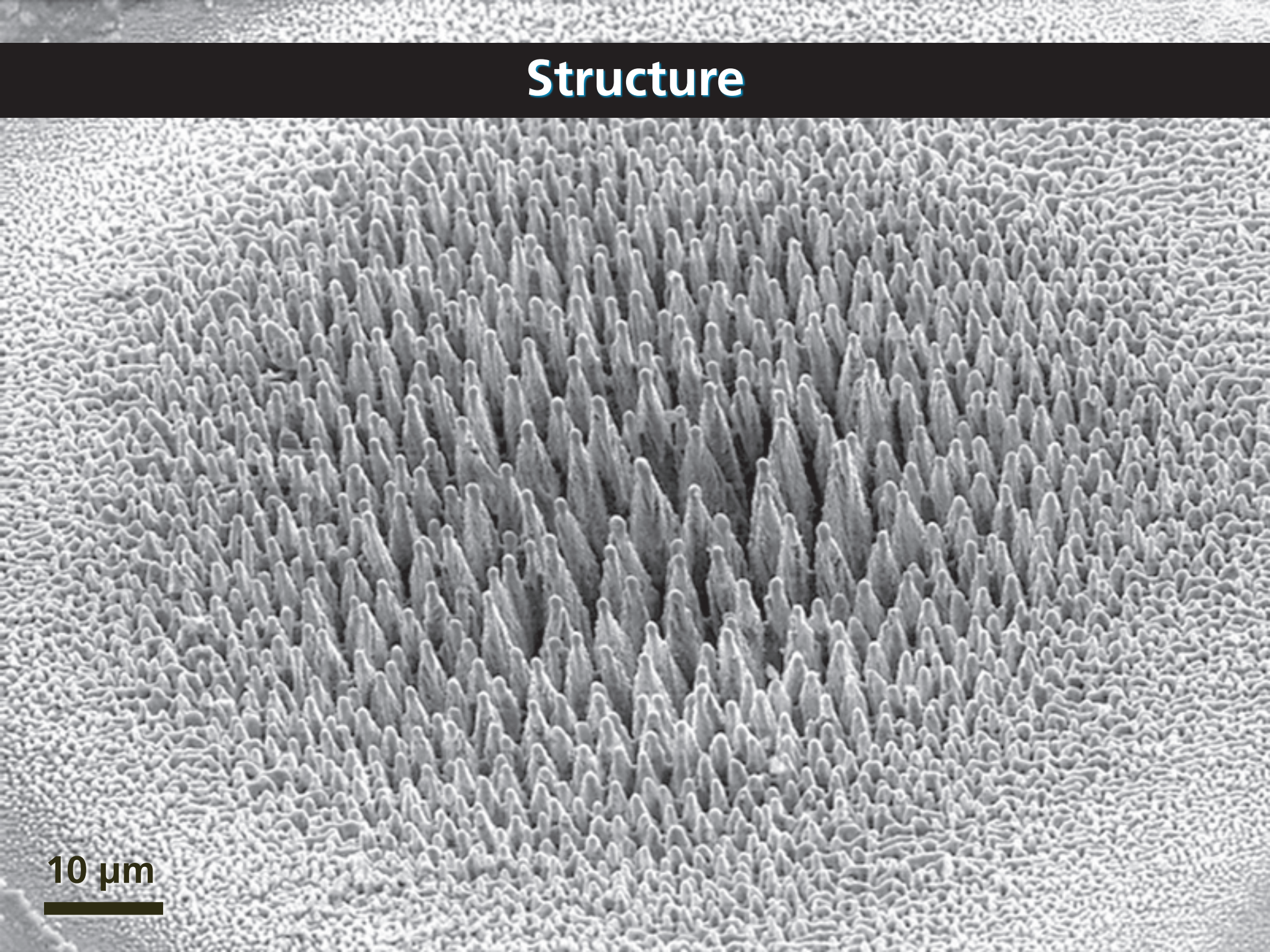


Introduction

absorptance ($1 - R_{int} - T_{int}$)



Structure



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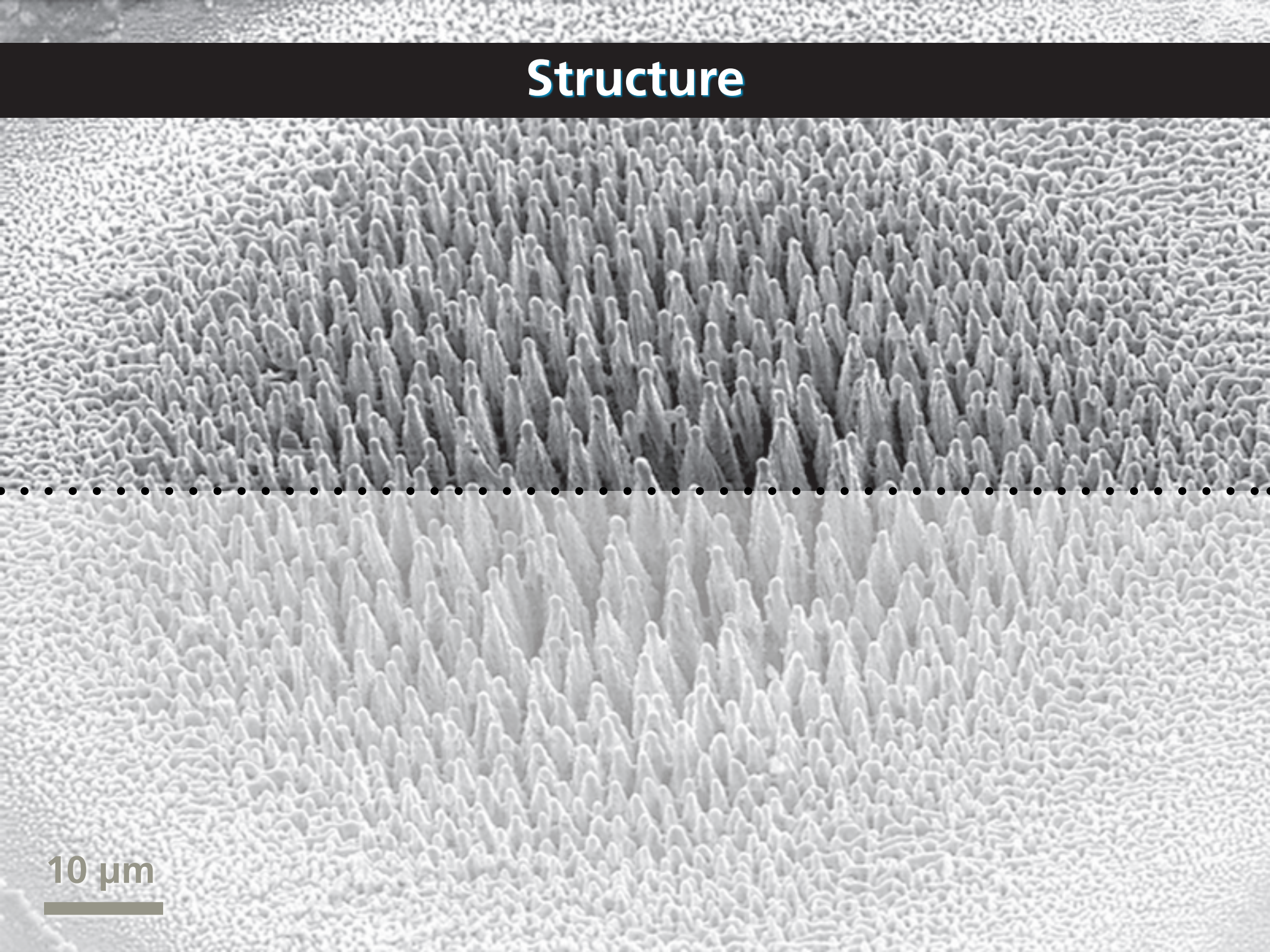

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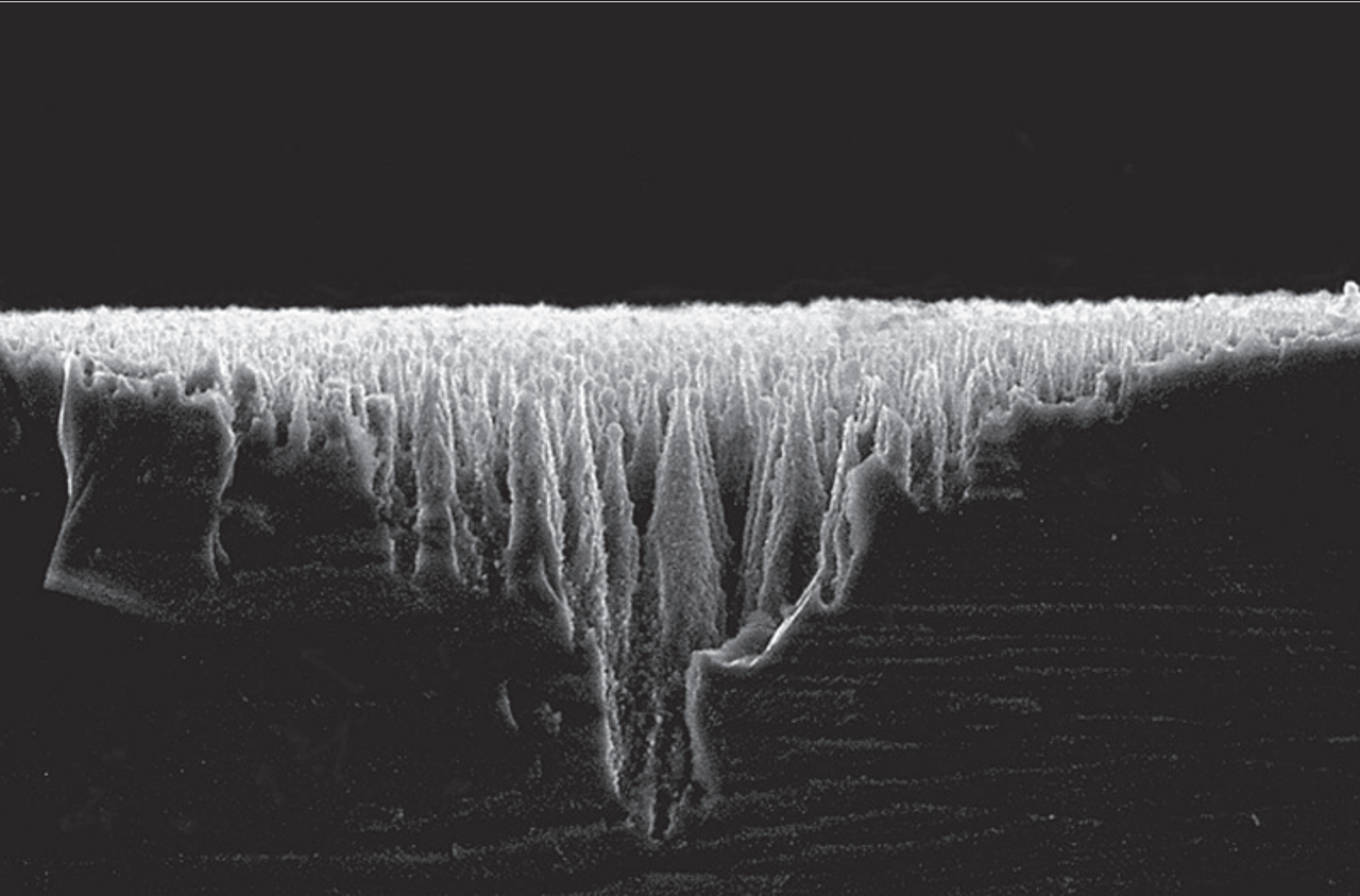
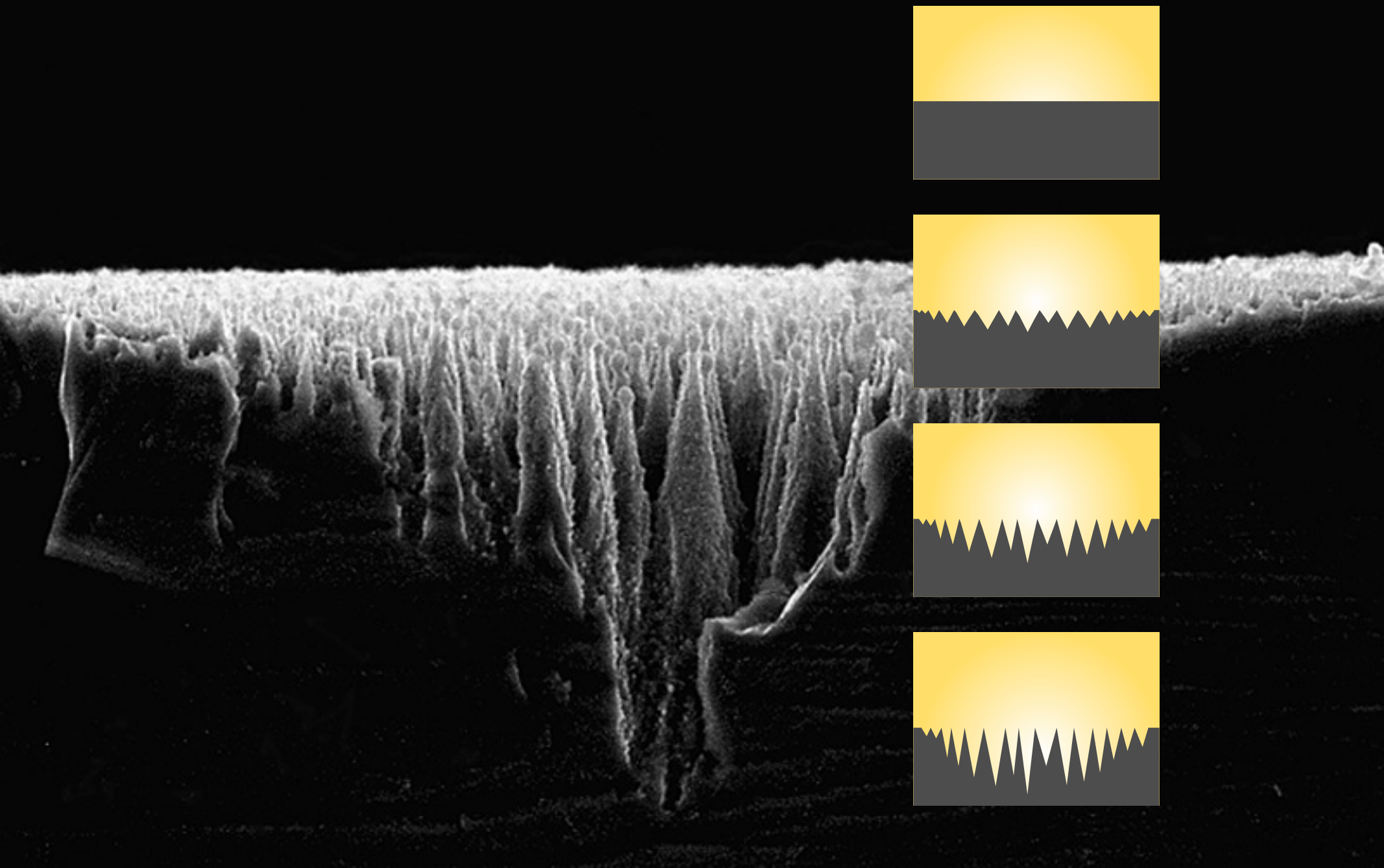


Structure



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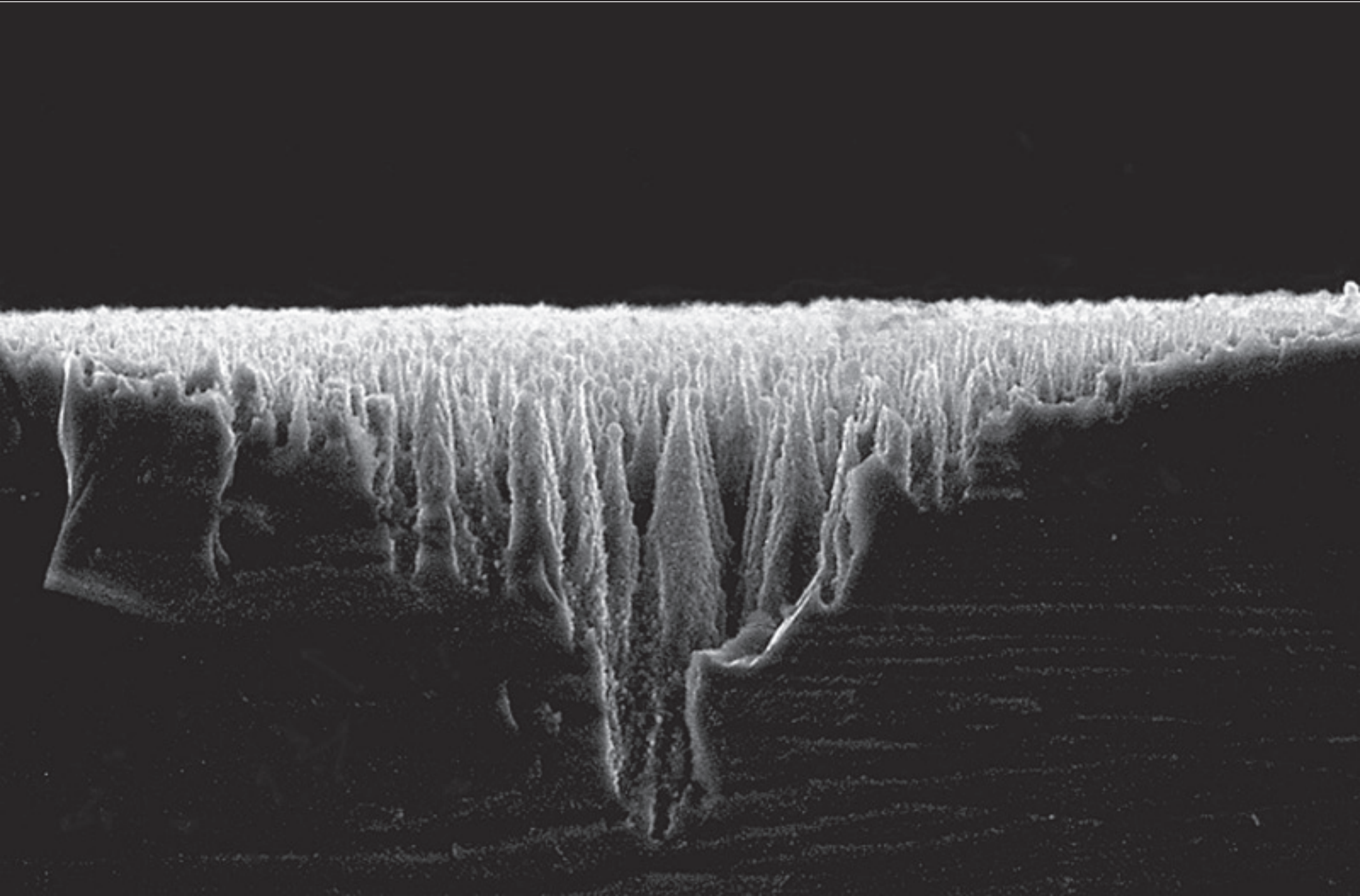

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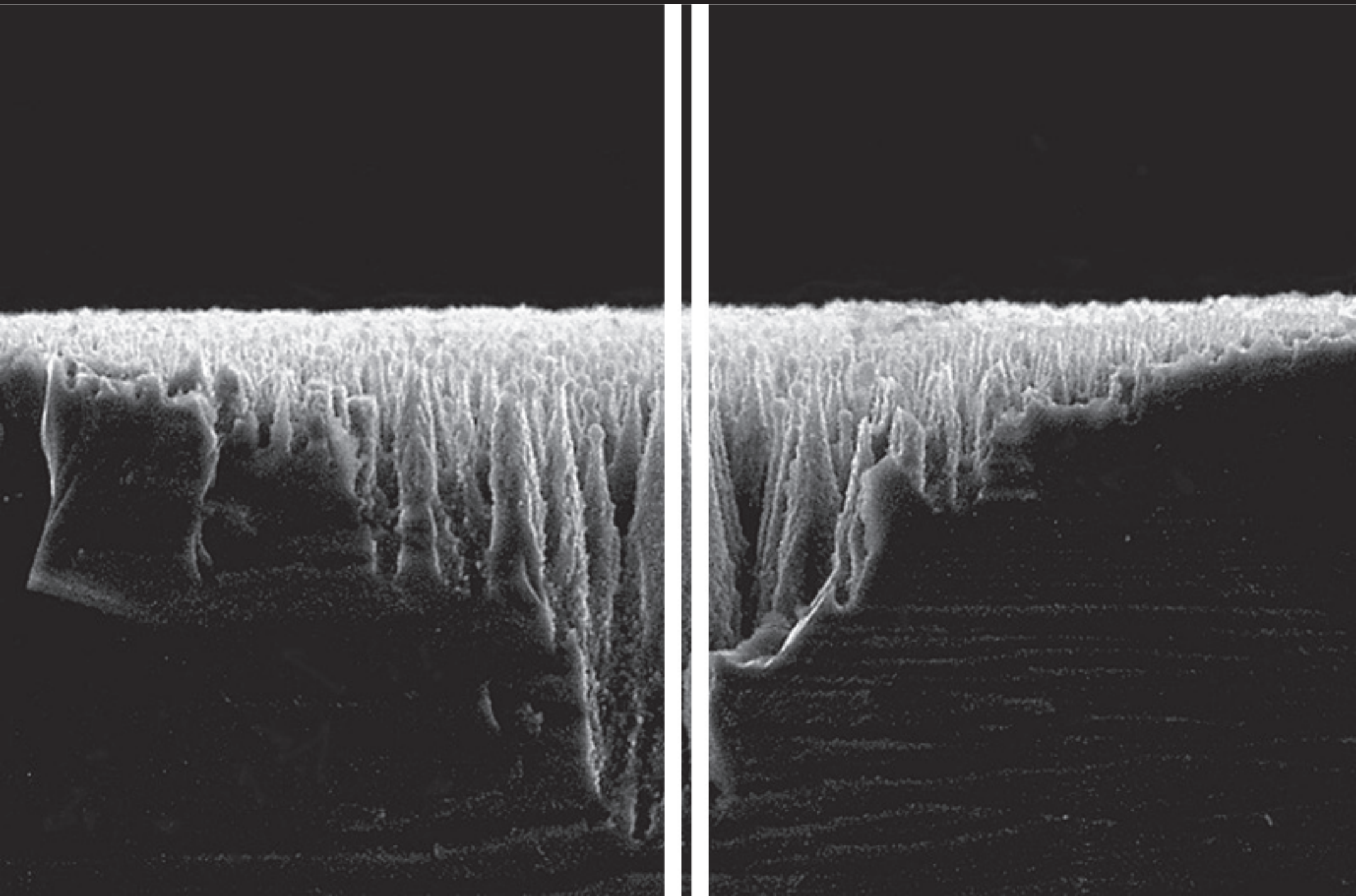
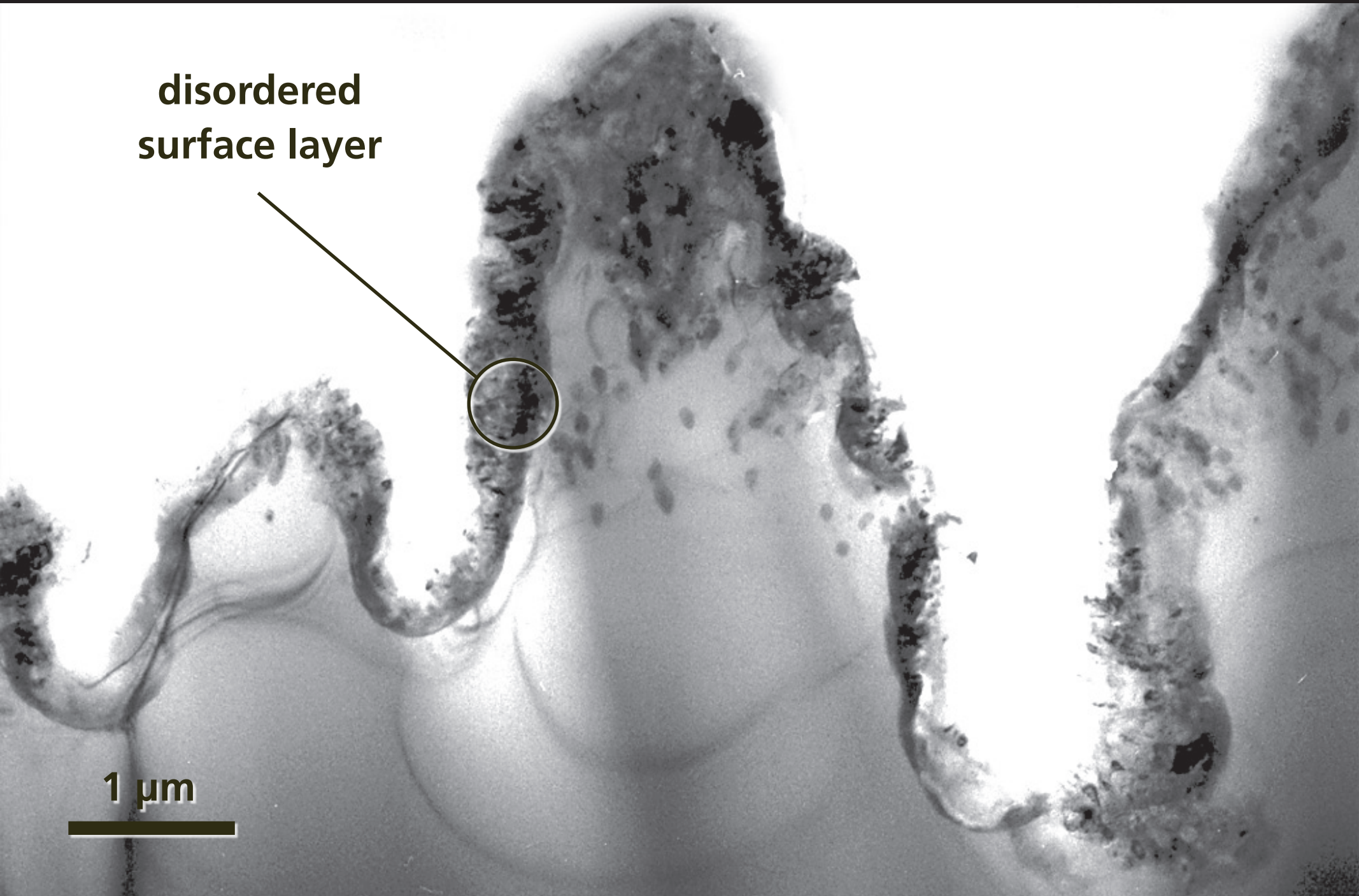


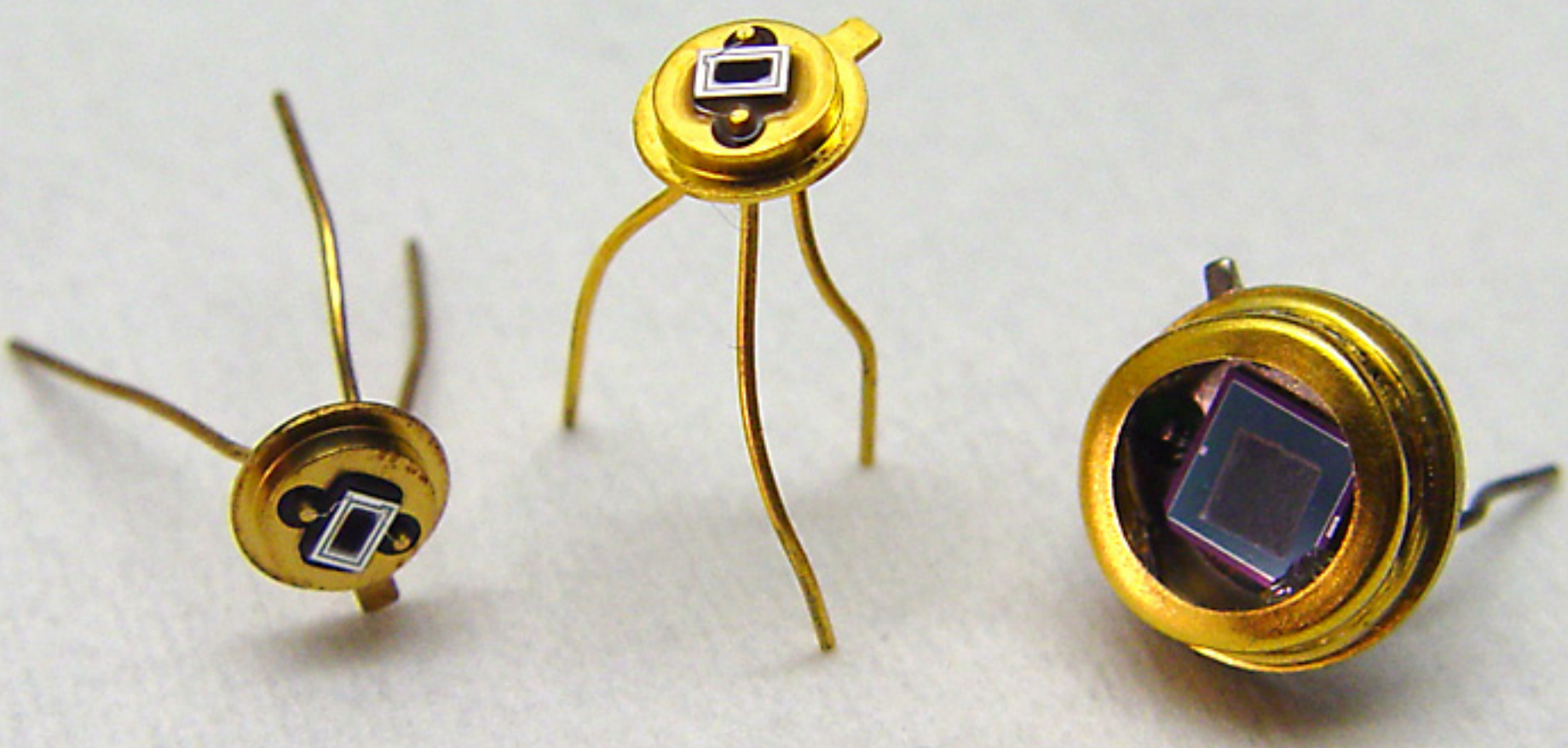
Structure

cross-sectional
Transmission Electron
Microscopy

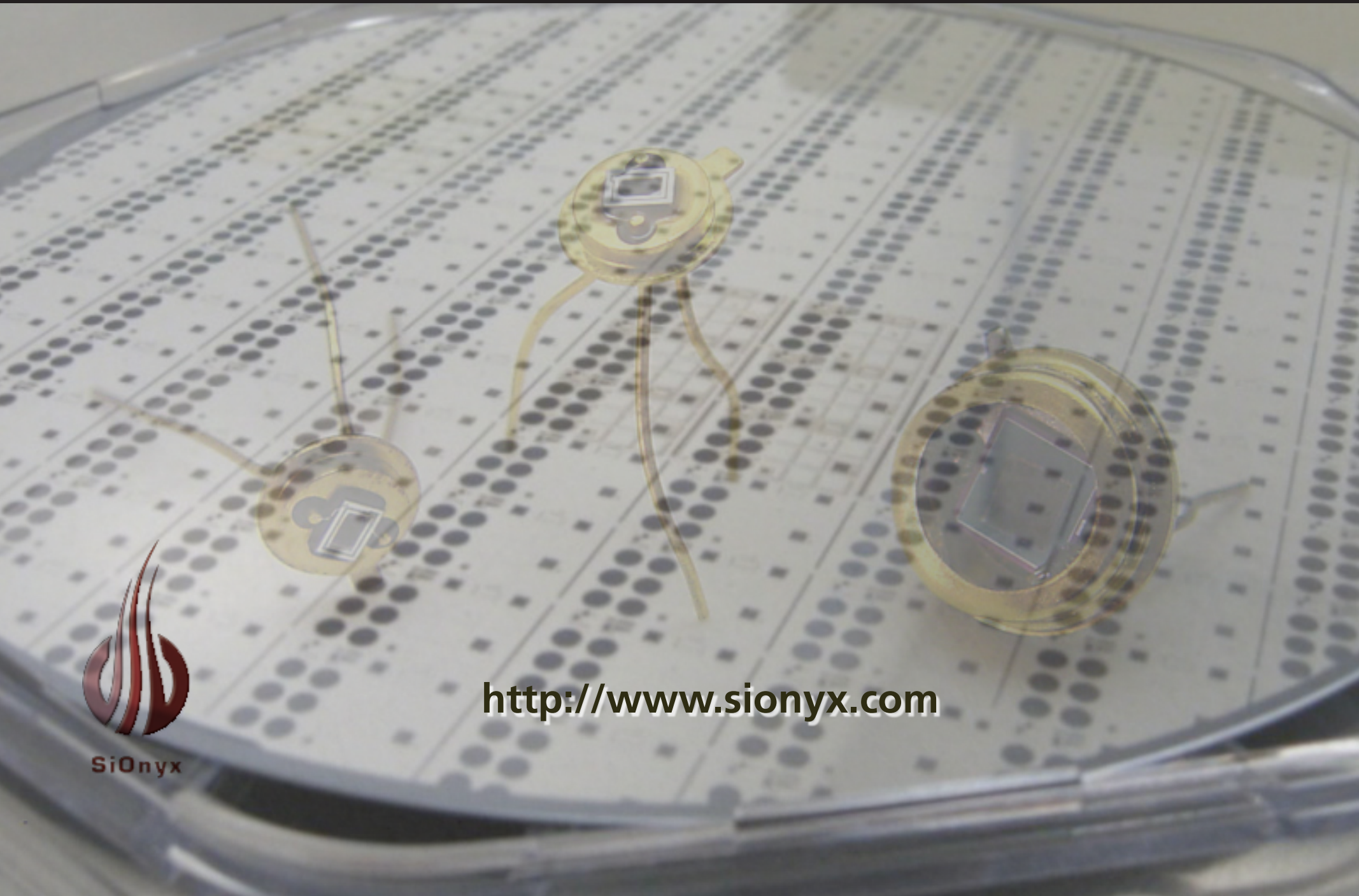
Structure



Devices

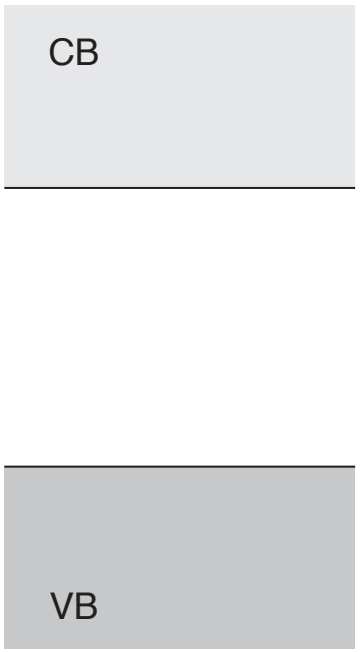


Devices



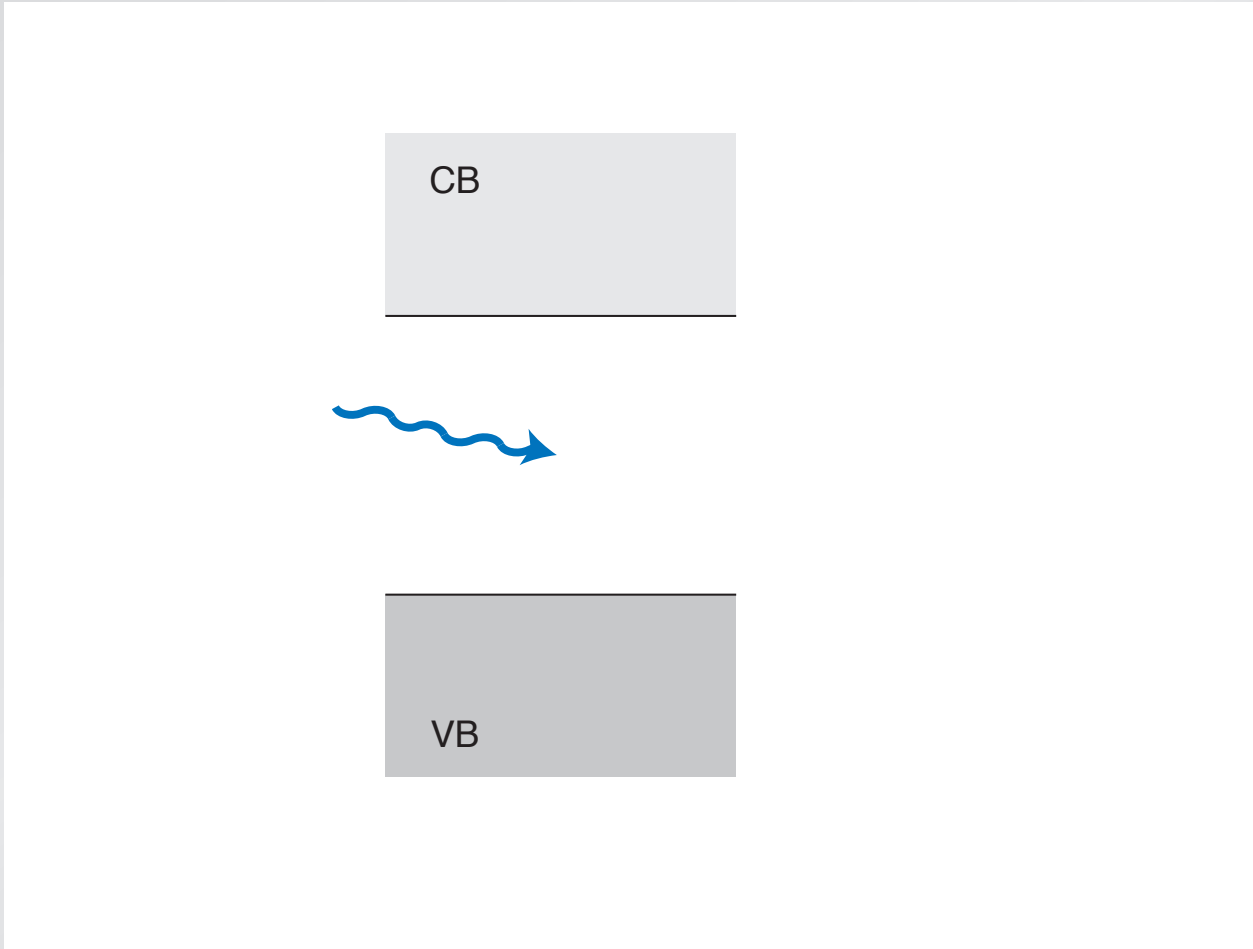
http://www.sionyx.com

Better photovoltaics?



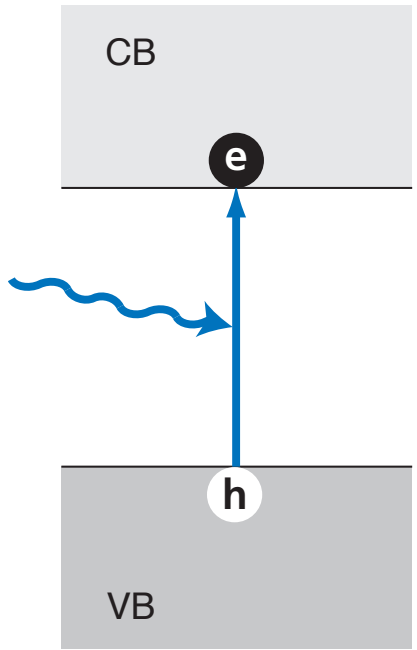
Better photovoltaics?

photon with gap energy



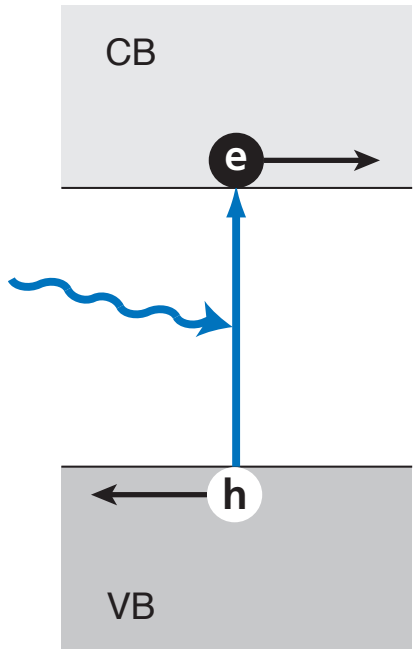
Better photovoltaics?

photon creates electron-hole pair…



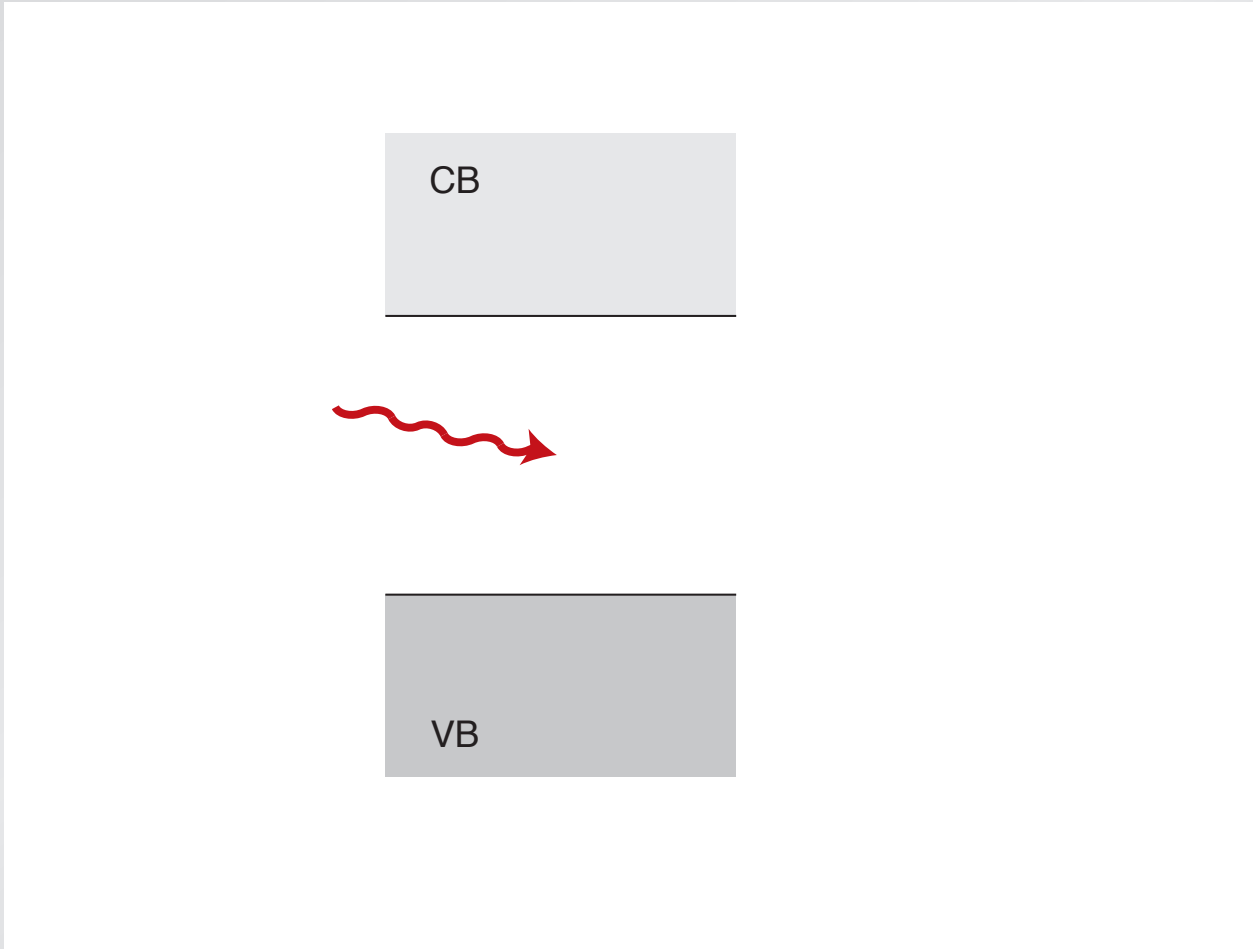
Better photovoltaics?

…whose energy can be extracted



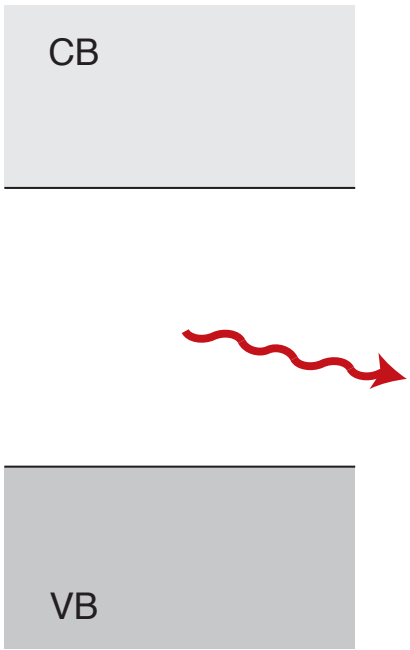
Better photovoltaics?

photons with energy smaller than gap…



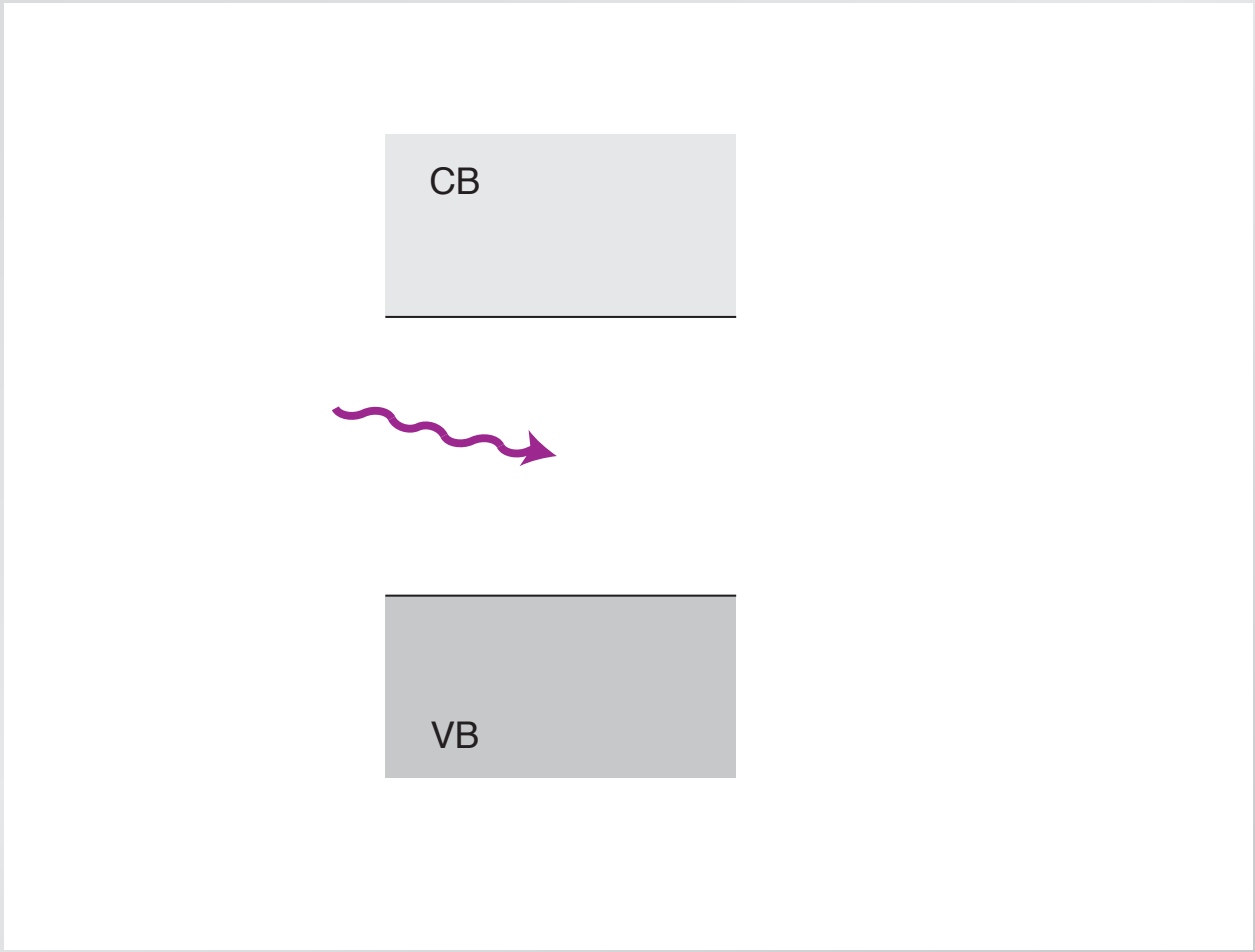
Better photovoltaics?

…do not get absorbed



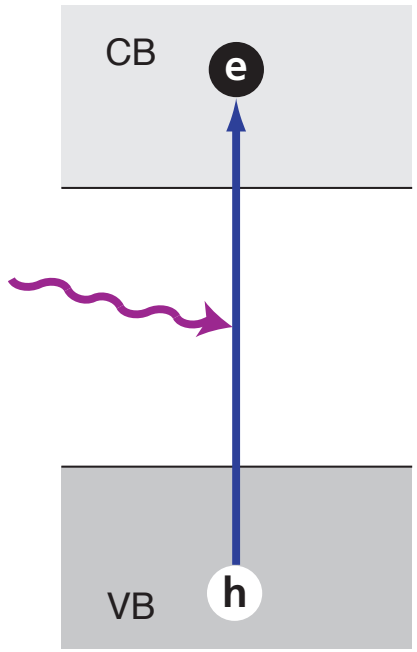
Better photovoltaics?

photons with energy larger than the gap…



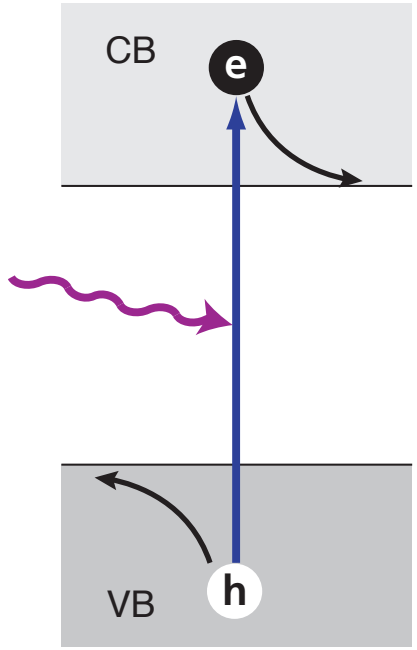
Better photovoltaics?

…create electron-hole pairs with excess energy…



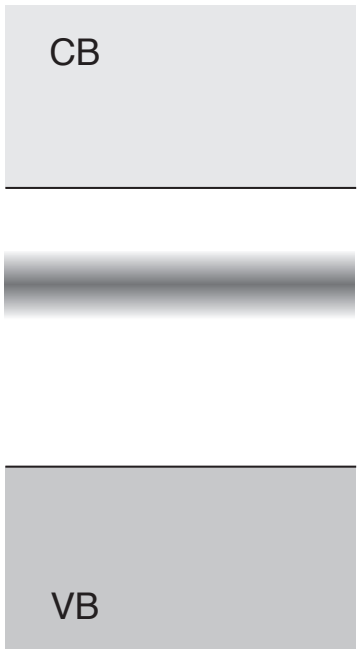
Better photovoltaics?

…which is lost rapidly



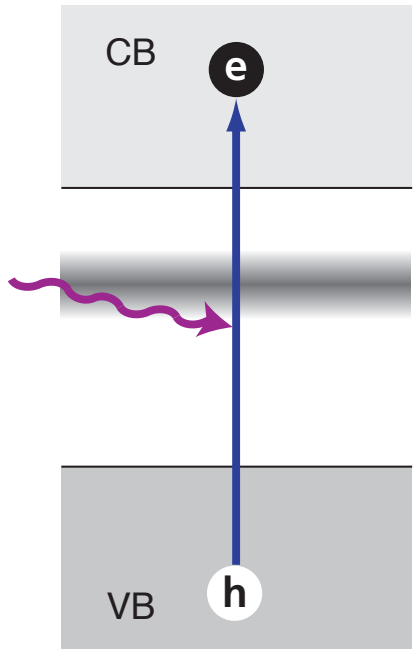
Better photovoltaics?

black silicon has an intermediate band



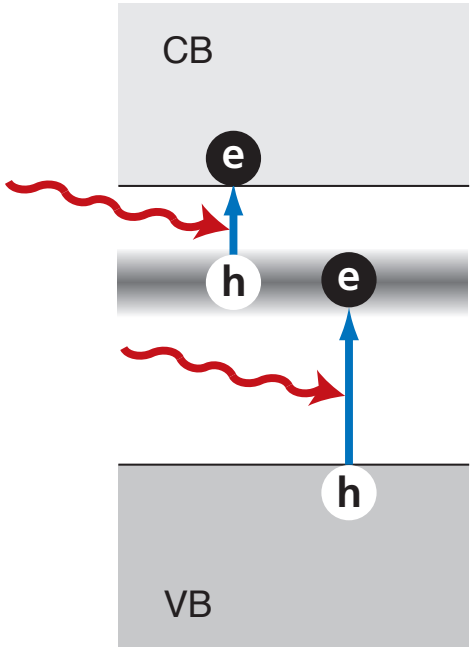
Better photovoltaics?

absorbs same photons as ordinary silicon…



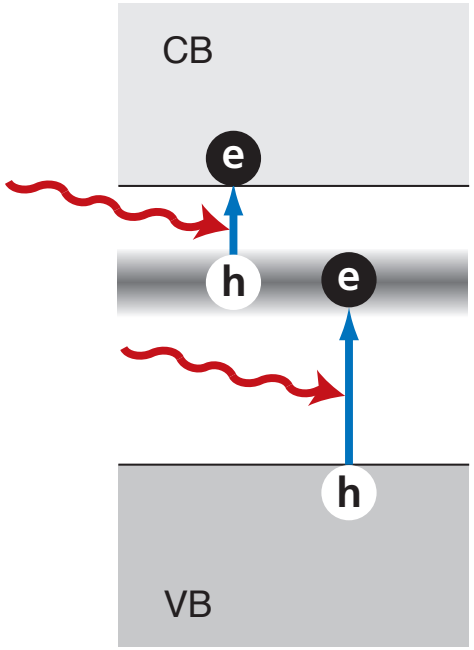
Better photovoltaics?

…but extends absorption to longer wavelengths



Better photovoltaics?

could theoretically get efficiencies over 50%



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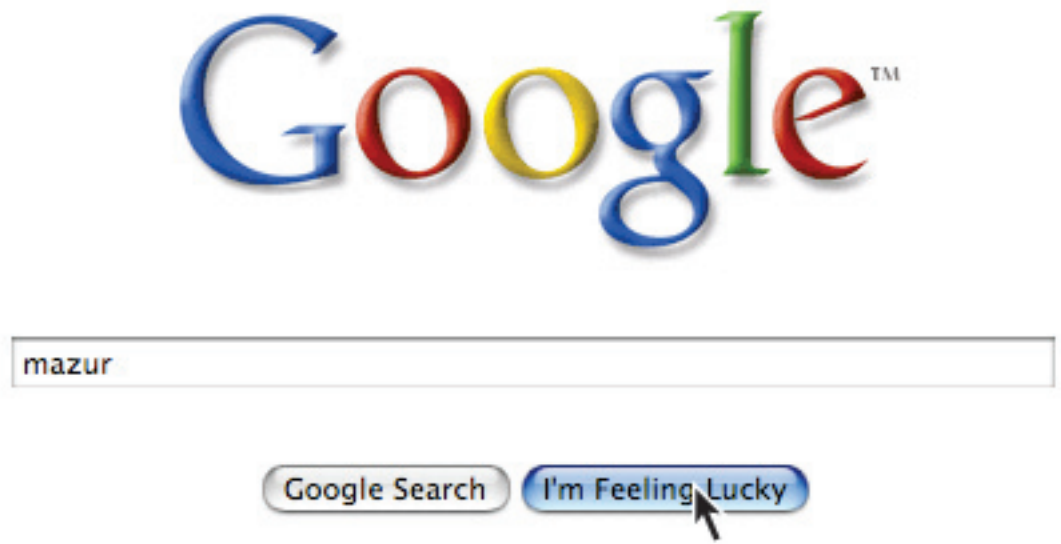
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