A forest of nanorods: Amazing nanostructures created by glancing-angle deposition

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Just as landscape photographs shot in low-angle light dramatically accentuate subtle swales and mounds, depositing metal vapors at glancing angles turns a rough surface into amazing nanostructures with a vast range of potential properties.

For decades, vapor deposition has been a standard technique for creating modern microelectronic circuits. But nearly all of industry's efforts have been devoted to making structures as flat and smooth as possible. Rather than placing metal sources in the high-noon position used to make featureless structures, Daniel Gall of Rensselaer Polytechnic Institute is one of several dozen research leaders who place them at very narrow angles akin to sunrise or sunset illumination. Metal atoms then hit primarily any high spots on the target surface. Continued deposition creates a forest of nanorods, rather than flat films, since each growing rod shadows a volume behind it. Starting with a patterned substrate yields a regular array of nanoscale columns, like skyscrapers in downtown Manhattan.

Gall describes his research today at the AVS 57th International Symposium & Exhibition, which takes place this week at the Albuquerque Convention Center in New Mexico.

In his talk, Gall reveals a new theory that predicts how the deposition temperature and diffusion affects the diameters of the nanorods.

"Atoms moving by surface diffusion typically smooth the surface," Gall says. "Atomic shadowing causes the opposite effects, making the surface rough. Glancing-angle deposition extends shadowing effects to higher temperatures, which lead to larger-diameter nanorods."

He also illustrates his presentation with images of a variety of nanostructures created in his lab, including curiously shaped half-moons made when he started with a pattern of self-assembled spheres.

Future applications for nanorod structures such as Gall's include nanosensors, optical elements, fuel-cell cathodes and electrical contacts for buffering thermal expansion.

More information: The presentation, "Nanorods by Extreme Shadowing: New Pictures and New Physics" is at 2:40 p.m. on Wednesday, October 20, 2010. ABSTRACT: www.avssymposium.org/Open/Sear … erNumber=SE+TF-WeA-3

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