LIGHT CONTROLS SELF-ASSEMBLY OF GALLIUM NANOPARTICLES

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Abstract: Light dramatically influences and regulates the self-assembly of gallium nanoparticles grown by atomic beam deposition.

Here we report for the first time that light can dramatically influence and regulate the nanoparticle self-assembly process: illumination of a substrate exposed to a beam of gallium atoms results in the formation of gallium nanoparticles with a relatively narrow size distribution. Very low light intensities, below the threshold for thermally-induced evaporation, exert considerable control over nanoparticle formation through non-thermal atomic desorption induced by electronic excitation.

We studied nanoparticle formation at the end of single-mode optical fibers exposed to an atomic gallium beam in vacuum. One end of the fiber was cleaved and mounted in the chamber on a cold finger at 100 K. The other end was connected to a 1.55 μm diode laser, producing 1 μs pulses at 1 kHz with 17 mW peak power. A layer with two distinct parts is formed (fig. 1a). Most of the surface is covered with structures of random shape and size (fig. 1b) but on the fiber's core, where laser light was present during deposition, a highly reflective area of nanoparticles with a narrow size distribution is formed (fig. 1c).

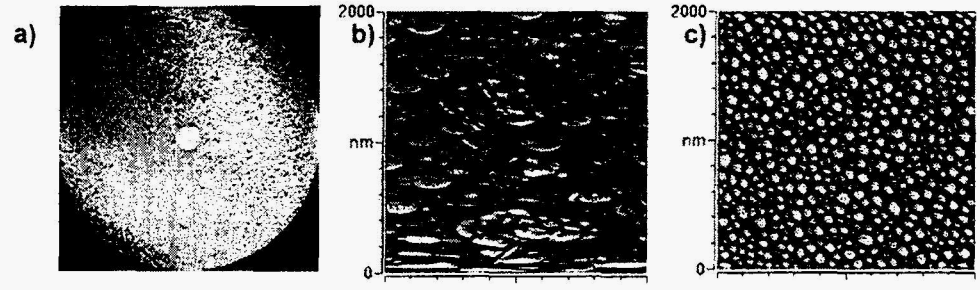

Fig. 2: [a] Optical image, in *reflection*, of a fiber end after 30 minutes of deposition. The bright spot corresponds to the fiber core where laser light was present during deposition [b] AFM image of an area outside the core (no light during deposition) showing gallium structures of vaying shape and size; [c] AFM image of an area inside the core (illuminated during deposition) showing nanpparticles with a narrow size distribution centered on ~ 80nm.

We have studied this process in detail and suggest a mechanism for the light-assisted formation of gallium nanoparticles that depends on desorption of gallium atoms from the particle at a rate controlled by shape/size-selective optical excitation.