

Nanoplasmonic structures from biogenic silica templating arrays derived from species of diatoms

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Background and Significance Periodicity in nanoplasmonics gives rise to many new optical effects. Typically, arrays are fabricated by creating holes by electron beam in thin metal films supported on a dielectric, or by nano-stamping, multi-level photomask patterning to create masks and resists for patterns, or by anisotropic etching in silicon to create pits to entrap nanoparticles. There is a need to explore a broad range of geometric patterns whose fabrication methods lie outside the micro- and nanofabrication approaches, but that nevertheless offer useful templates for making patterned nanoplasmonic arrays. Naturally occurring diatoms offer such an opportunity, and it is this opportunity that we are exploring with the support of the infrastructure in the Nanotools facility. Diatoms are single cell micro-organisms that mineralize silica from water and create an amorphous silica exoskeleton (frustule) that is highly geometrically patterned with pores. It is possible 1) to metabolically insert photoactive species (rare earth ions) into the silica framework to make upconverting structures; 2) to insert nanoplasmonic particles in the pores to create periodically template arrays; 3) to create photonic crystal constructs; 4) to create magnetic and meta-material constructs.

Methodology In our proof of principle experiments, we have deposited 5-15 nm gold films by electron beam evaporation onto the frustules of *Nitzschia Palea* (Figure 1).

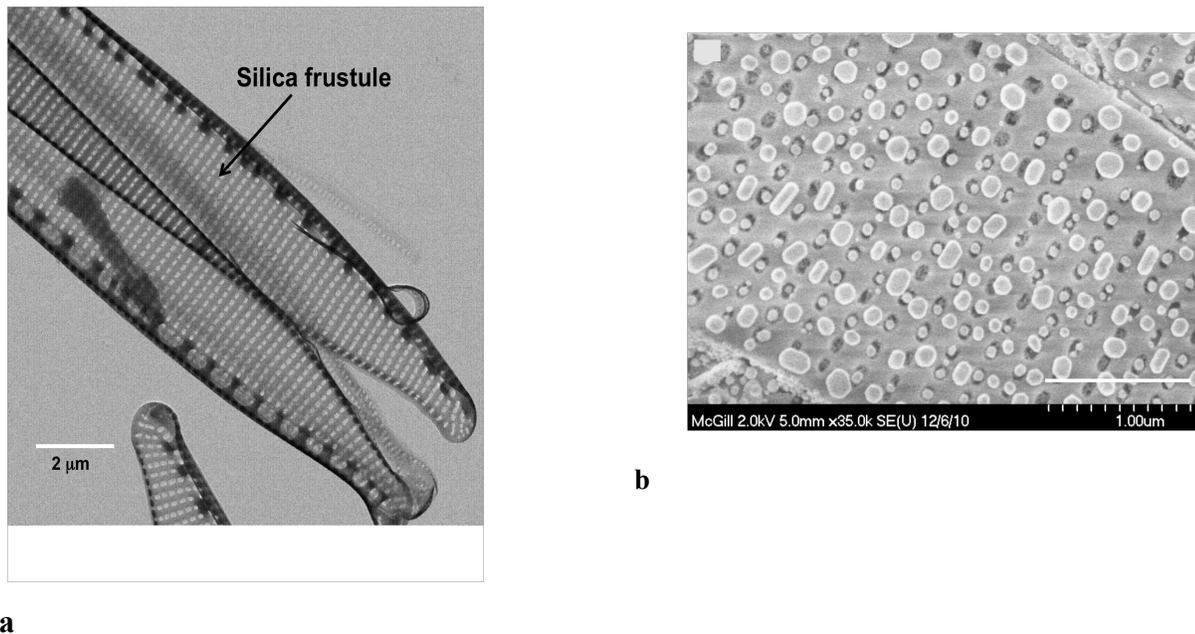


Figure 1: (a) Transmission electron microscope image of *Nitzschia Palea* frustules. Evident are rectangular foramina (pores) arranged in periodic (triangular lattice) fashion over the silica surface. (b) SEM Image of *Nitzschia* frustules coated with 10 nm gold film and annealed 10 minutes at 700 °C. White scale bar is 1000 nm (1 μm).

The gold films undergo dewetting instabilities driven by spinodal effects and hydrodynamic forces moderated by curvature (Figure 1b). The frustules also behave as shadow masks for creating patterned nanoplasmonic arrays (Figure 3).

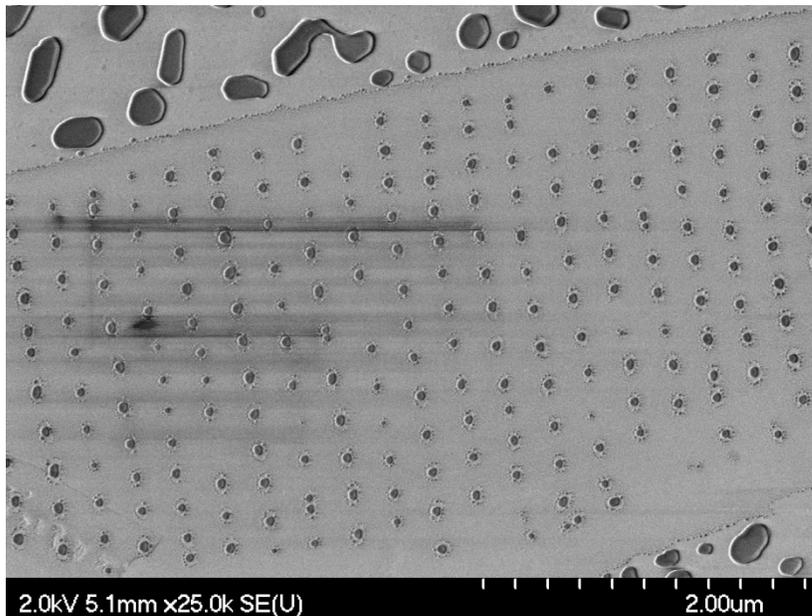


Figure 2. SEM Image of shadow mask effect from Nitzschia frustule coated with 10 nm gold film and annealed 120 minutes at 600 °C.

Collaborators -

Selected publications (“Nanoplasmonic photonic crystal diatoms and phytoliths “ Mark P. Andrews*, Ahmadreza Hajiaboli , Jonathan Hiltz, Timothy Gonzalez, Gursimranbir Singh, and R. Bruce Lennox SPIE Proceedings ,in press, 2011

Patents

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