

Advanced 3D photonic crystal structures as challenges: robot-aided manipulation v selfassembly
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3D photonic crystals
 full control of light
 improve performance
 architectures -> diamond lattice
 fab techniques -> microlithography
 -> no selfassembly
 materials
 new materials
 new synthetic approaches
 outlook
 millipede

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ULTIMATE LITHOGRAPHY AND NANOFABRICATION FOR ELECTRONICS AND LIFE

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3D 2D 1D

Real space

Reciprocal space

Dimensionality

Periodicity in one dimension produces stop bands in that direction. If appropriate periodicity can be produced in all three directions of space a stop band can be induced that forbids light propagation irrespective of light direction for a certain range of

Band Gap Opening

High symmetry
 High refractive Index Contrast
 Complex Primitive Cell
 Low filling fraction

High Aspect Ratio
 Low Refractive Index Contrast
 Extreme filling fraction

Energy

Energy

2c, r₁+2R(c-r₁)
 2c, r₂-R(c-r₂)

Band structure plots showing energy vs momentum (Gamma-M-N-Gamma) for structures with and without a photonic band gap (PBG). A diagram of a primitive cell is also shown.

[110] Section

Drilled hole

Air

Dielectric

Yablonovite

Yablonovite constitutes the first 3D PBG structure built. Its dimensions make it work in the microwave region of the electromagnetic spectrum.

Frequency (reduced units)

PBG

X U L Gamma X W K

Dissolve silica

Layer by layer wood pile

Side view

Top view

Layer by layer wood pile

poly-Si

Si Substrate

Lin, Nature 394, 251 (1998)

Photonic band structure plot showing frequency vs wavelength (nm) for a layer-by-layer wood pile structure.

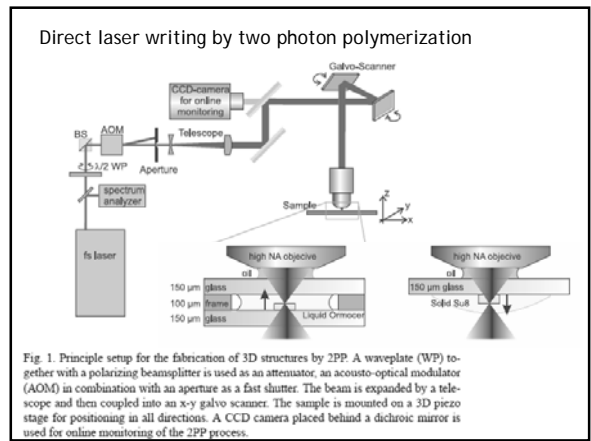
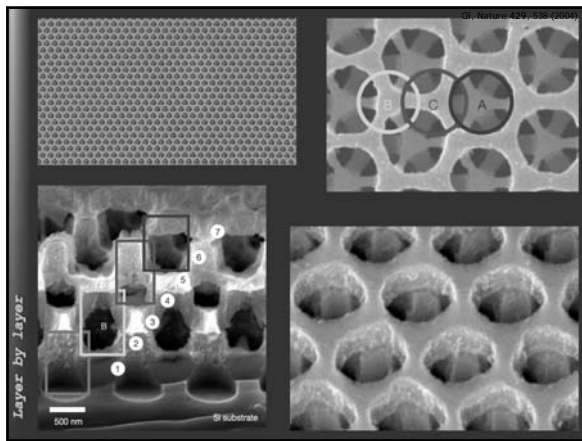
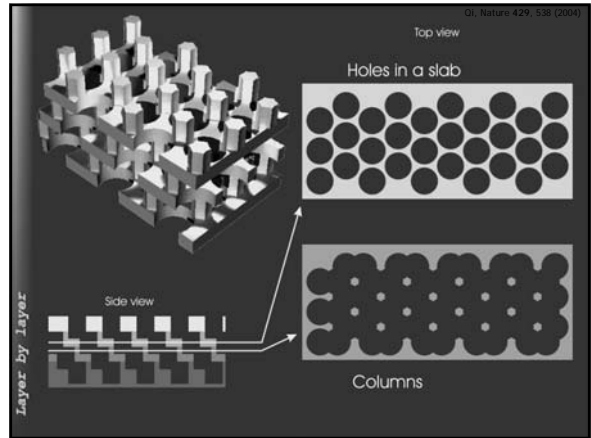
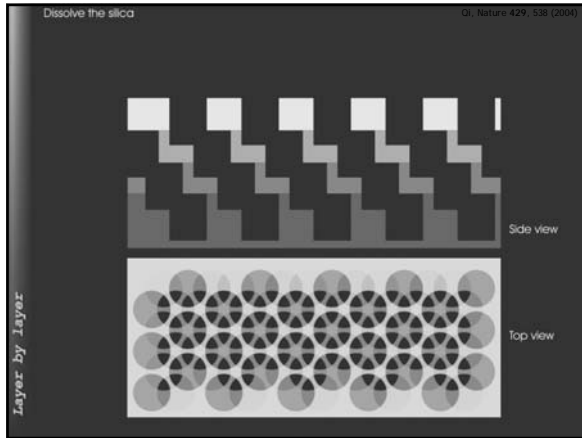
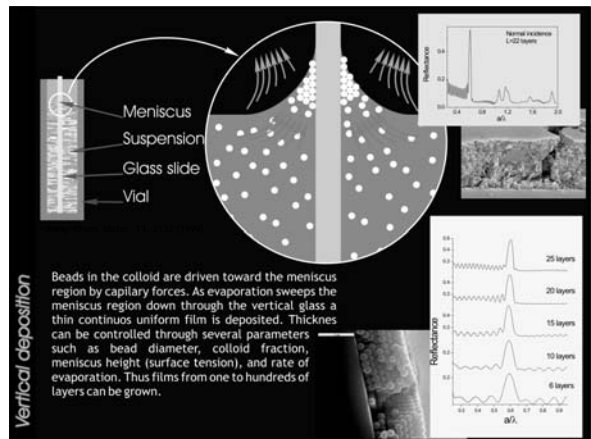
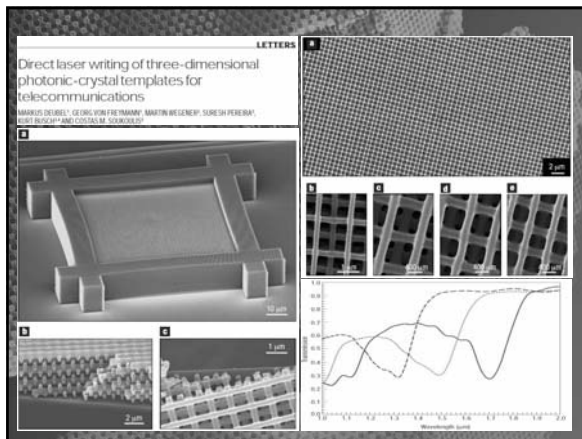
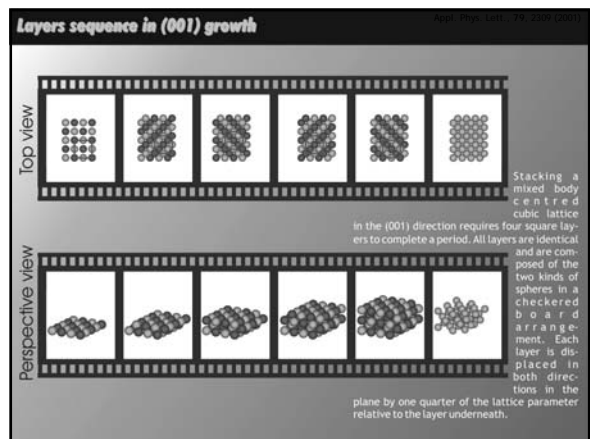
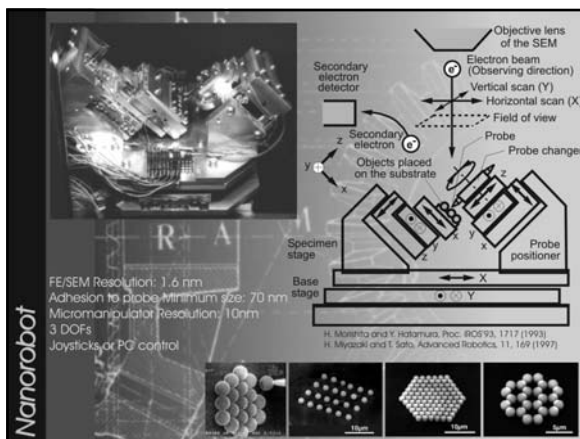
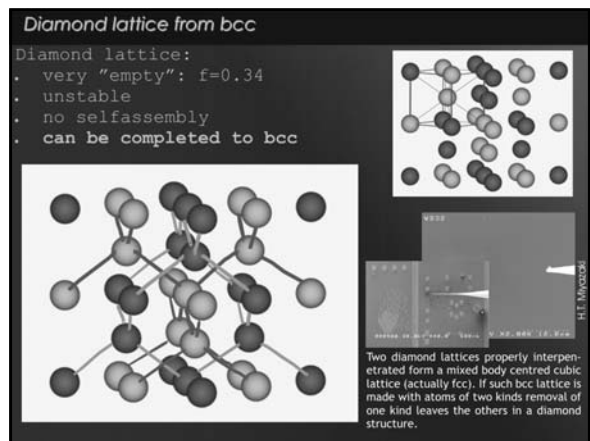
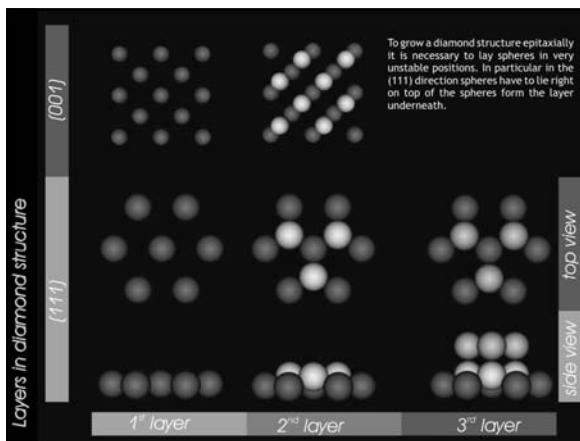
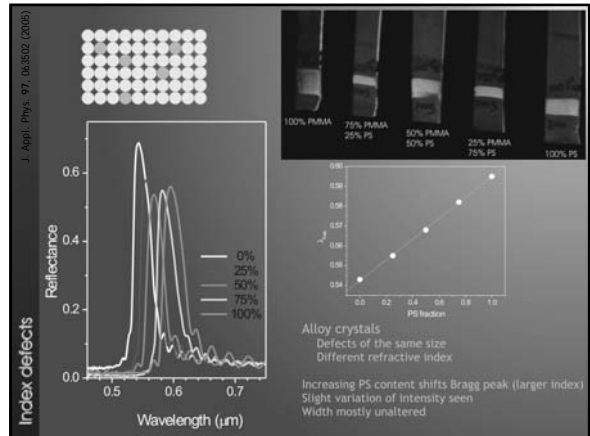
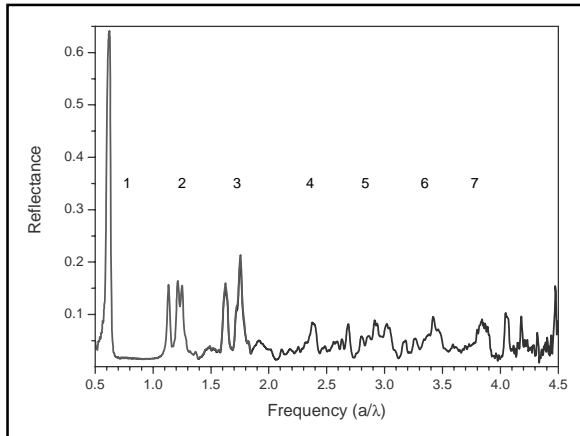
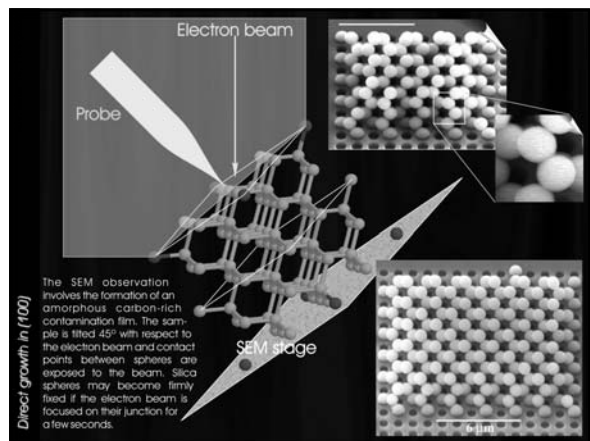
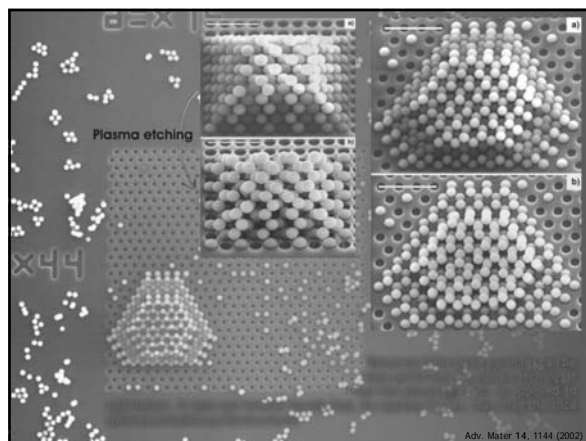
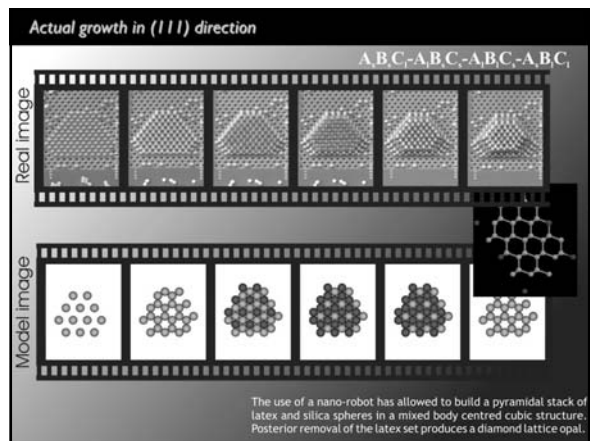
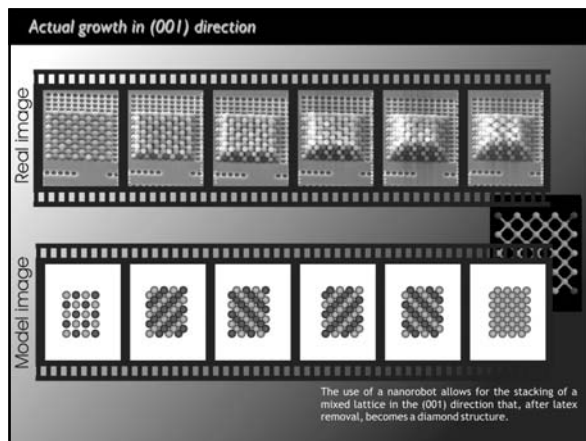
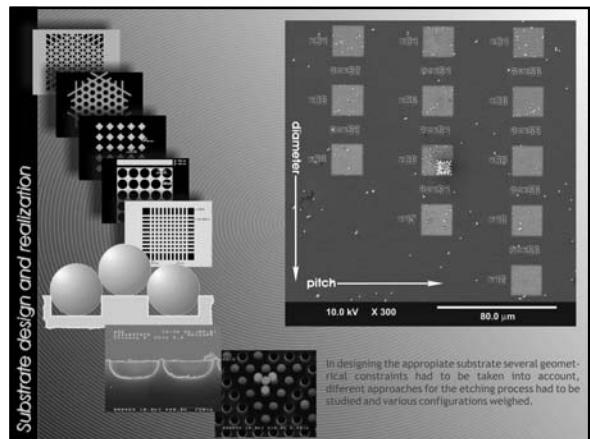
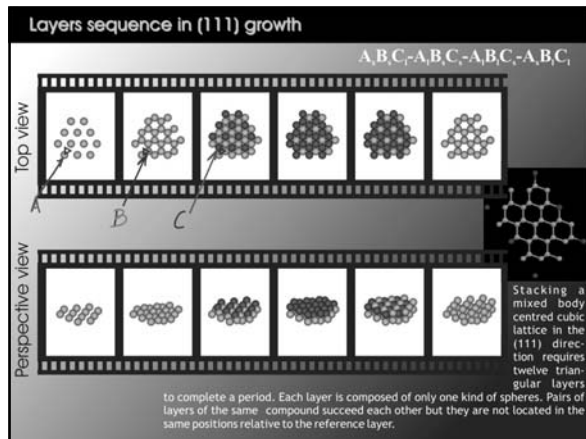
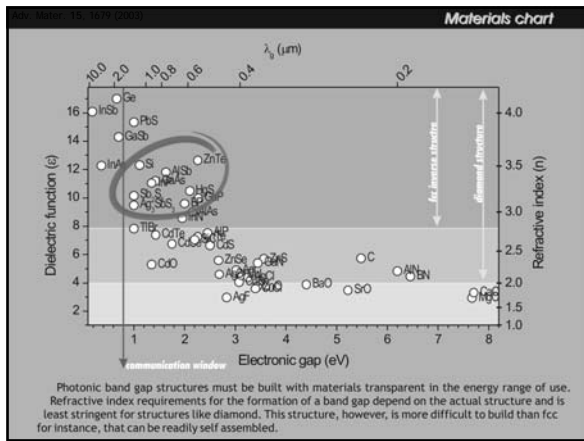
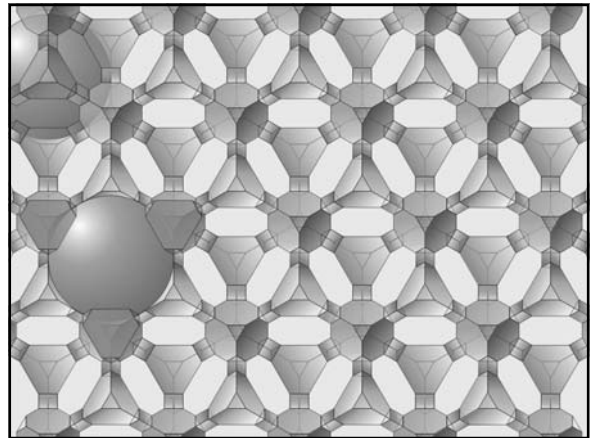
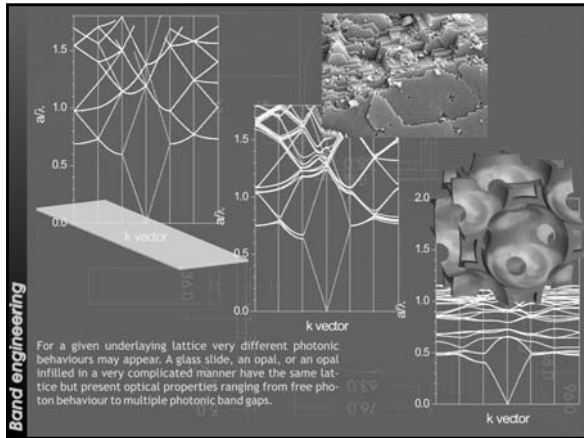


Fig. 1. Principle setup for the fabrication of 3D structures by 2PP. A waveplate (WP) together with a polarizing beamsplitter is used as an attenuator, an acousto-optical modulator (AOM) in combination with an aperture as a fast shutter. The beam is expanded by a telescope and then coupled into an x-y galvo scanner. The sample is mounted on a 3D piezo stage for positioning in all directions. A CCD camera placed behind a dichroic mirror is used for online monitoring of the 2PP process.



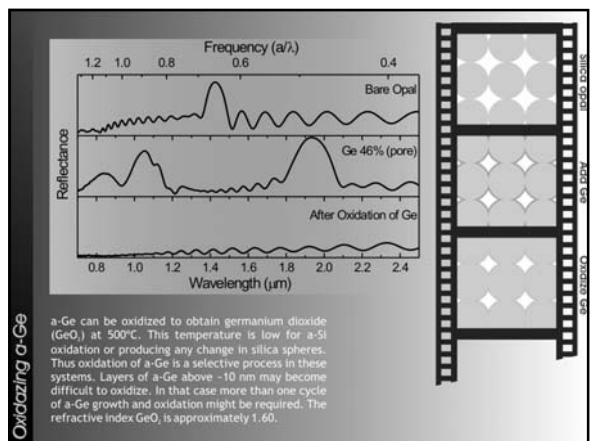


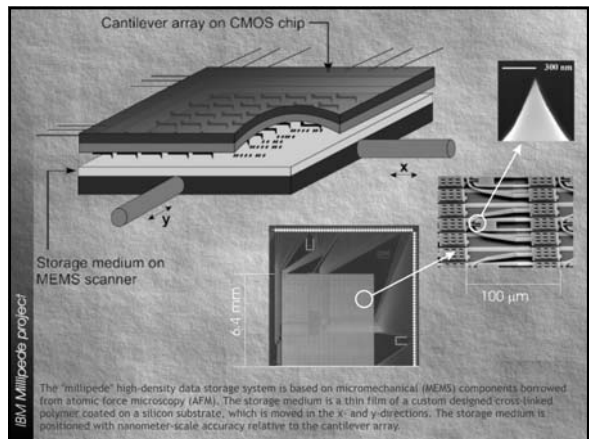
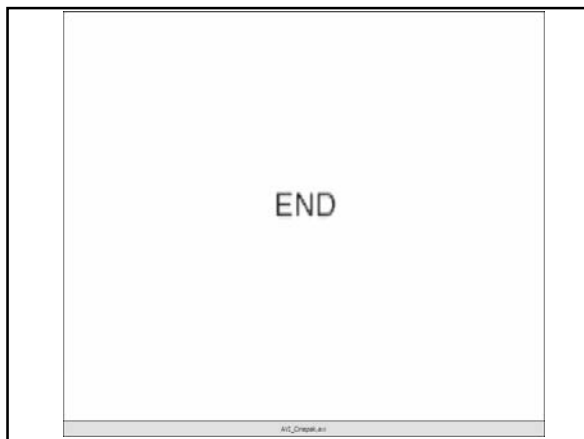
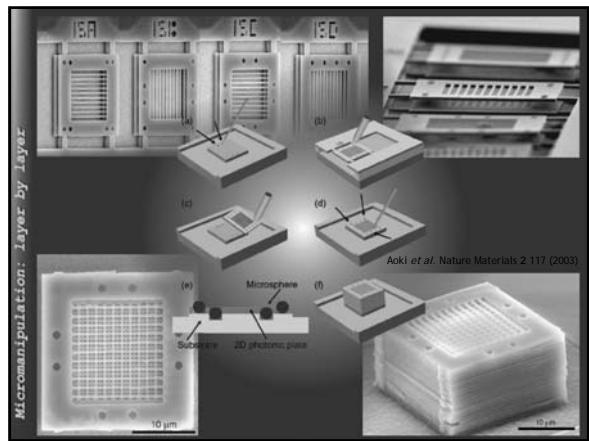
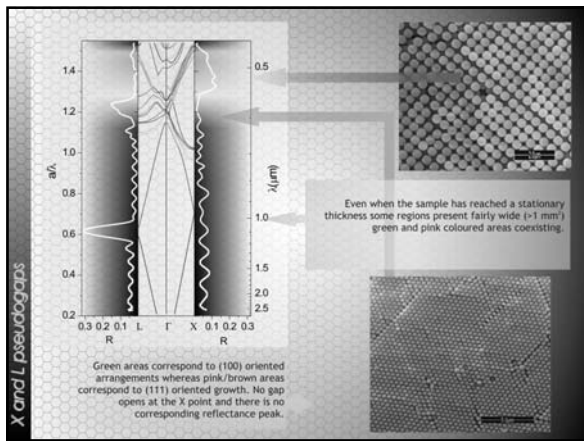
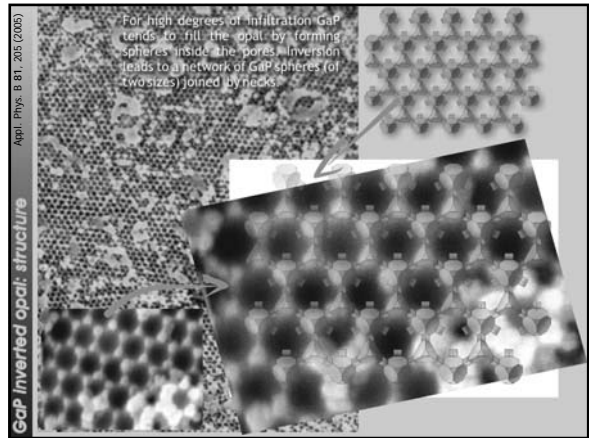
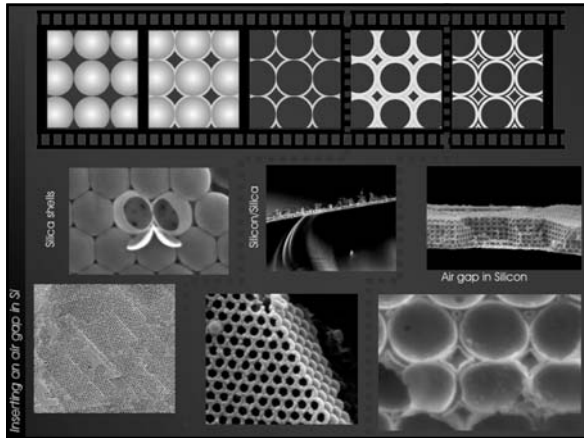




Opals as hosts for photonic materials

- Polymer Inverse Opal
- Sb₂S₃ Inverse Opal
- Silicon Inverse Opal
- Germanium Inverse Opal
- InP Infiltrated Opal
- InSb Inverse Opal
- Ge Inverse Opal: Detail of an Internal (110) Facet





CAST

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