Self Assembled Photonic Crystals

1 D PC

**Distributed Bragg reflector (DBR)** Each layer boundary causes a partial reflection of an optical wave.
Self Assembled Photonic Crystals

3 D PC

Opals and reverse Opals
We report herein on a facile and reproducible approach to prepare mesoporous nanoparticle-based distributed Bragg reflectors (DBRs) from a diverse group of metal oxide nanoparticles including SiO\textsubscript{2}, TiO\textsubscript{2}, SnO\textsubscript{2}, and Sb:SnO\textsubscript{2}.

DBRs are one-dimensional PCs.

They consist of multiple layers of two alternating materials with varying dielectric constants.

Each layer boundary causes a partial reflection of an optical wave with many boundaries giving rise to multiple reflections.
SEM images of representative nanoparticle DBRs. For SiO$_2$/TiO$_2$ the scale bar represents 0.5 µm and for the remaining, the scale bars represent 1 µm.
In general, to prepare a single DBR, a pair of two different metal oxide nanoparticle compositions was spin-coated from modified dispersions iteratively until the desired number of layers was deposited.

Prior to spin-coating each dispersion was stirred thoroughly, sonicated for 10 min and filtered through a 200 nm pore syringe filter to remove any aggregates.

Following each bilayer deposition, for the SiO2/TiO2, SiO2/SnO2 and SiO2/ATO nanoparticle DBRs, thermal treatment involving bathing at 450 C for 20 min was incorporated into the methodology.

<table>
<thead>
<tr>
<th>Material</th>
<th>Concentration/wt%</th>
<th>Additive/wt%</th>
<th>$n_{\text{eff}}$</th>
<th>Porosity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO2</td>
<td>5.8</td>
<td>---</td>
<td>1.21</td>
<td>38</td>
</tr>
<tr>
<td>TiO2</td>
<td>5.0</td>
<td>1.25–2.5 PEG$^a$</td>
<td>1.80</td>
<td>34</td>
</tr>
<tr>
<td>SnO2</td>
<td>13.9</td>
<td>---</td>
<td>1.55</td>
<td>28</td>
</tr>
<tr>
<td>Sb:SnO2</td>
<td>10.1</td>
<td>0.5–1.0 PEG$^a$</td>
<td>1.24</td>
<td>51</td>
</tr>
</tbody>
</table>

$^a$PEG: Polyethylene glycol
We describe a reflective flat-panel display technology based on the electrical actuation of photonic crystals.

These materials display non-bleachable structural colour, reflecting narrow bands of wavelengths tuned throughout the entire visible spectrum by expansion and contraction of the photonic-crystal lattice.
The first component in our P-Ink system is an inactive structural scaffold made of an ordered array of silica microspheres, and the second comprises a crosslinked network of polyferrocenylsilane (PFS), an iron-based metallopolypolymer.

The crosslinked PFS network component actively mediates the lattice spacing of the silica spheres through an electrochemically driven swelling and shrinking process.
c, Image of an assembled multipixel electrochemical cell with attached electrode leads.
d,e, The same cell after oxidizing the middle pixel with 1.5 V (d) and 2.0 V (e).
From colour fingerprinting to the control of photoluminescence in elastic photonic crystals

ANDRÉ C. ARSENAULT, TIMOTHY J. CLARK, GEORG VON FREYMANN, LUDOVICO CADEMARTIRI, RICCARDO SAPIENZA, JACOPO BERTOLOTTI, EVANGELLOS VEKRI, SEAN WONG, VLADIMIR KITAEV, IAN MANNERS, R. Z. WANG, SAJEEV JOHN, DIEDERIK WIERSMA AND GEOFFREY A. OZIN
Fluorescence modulation with photochromic switches in nanostructured constructs

Ibrahim Yildiz, Erhan Deniz and Francisco M. Raymo*

Received 27th October 2008
First published as an Advance Article on the web 4th February 2009
DOI: 10.1039/b804151m

Photochromic compounds switch reversibly between two states with distinct absorption properties in the visible region under the influence of electromagnetic radiation.
2. Fluorescence modulation
Nanostructures with reversible photoswitchable fluorescence potential applications in the fields of both optical information recording and Bioimaging.

The possible photodegradation of organic photochromic dyads under photo irradiation may prevent repetitive use of the nanostructures.

both active components are inorganic nanomaterials: photochromic Preyssler-type polyoxometalates $K_{14}[Na(H_2O)P_5W_{30}O_{110}]$ (Na-POMs) and luminescent core-shell CdSe@CdS NPs.
Polyoxometalate-Based Electro- and Photochromic Dual-Mode Devices

Shaoqin Liu,† Helmuth Möhwald,† Dirk Volkmer,§ and Dirk G. Kurth*†,‡

Max Planck Institute of Colloids and Interfaces, Research Campus Golm, 14424 Potsdam, Germany, National Institute for Materials Science, 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan, and Universität Ulm, Anorganische Chemie II, Albert-Einstein-Allee 11, 89081 Ulm, Germany
• **Layer-by-layer (LbL) technique:** alternative adsorption of negative charged Na-POMs or CdSe@CdS NPs and the positive-charged polyelectrolyte (poly(ethyleneimine), PEI) pair.

• **Na-POM components** in the nanostructured films are well-known to exhibit **reversible, high contrast photo- and electrochromic** characteristics upon photo- or electrochemical stimulation.
The as-prepared nanostructured film under ambient conditions exhibits a strong fluorescence peak centered at 600 nm (curve 1 in Figure 2A). After exposure to UV light of intensity of 396 mW/cm² for 30 s, the fluorescence of the nanostructured film is dramatically quenched. Further, when the UV-irradiated film is kept under room light (intensity: 0.5 mW/cm²) in air for 24 h, the fluorescence of the nanostructured film is recovered and the integral fluorescence area reaches 90% the recovery time shortens to 1 h in air when the film is exposed to the visible light of intensity of 985 mW/cm².
Figure 3. Confocal fluorescence microscopy images of [(PEI/Na-POM)9/PEI/CdSe@CdS]10 multilayer film on silicon substrate via the process of writing (A) - erasing (B) - writing (C) in the pattern experiment.
Photochromic materials have attracted extensive attention in reversible optical memory, where information can be written, read, and erased in binary states using different photons.
Figure 4. a) Fluorescence emission spectra of the BP BTE/coumarin loaded PMMA film on the matched PC and glass surfaces (insert) before (solid line) and after (dashed line) irradiation with 365nm light for 5 min at room temperature. b) The modulated emission intensity of the film on the PC surface during alternating irradiation with UV and visible light.

- A 40-fold enhancement of fluorescence signal and a sevenfold ON/OFF ratio amplification relative to the glass are realized due to the efficient extraction and large surface areas of the PC.