More on porous Si: Work from M. J. Sailor

Bulk Si, with a bandgap at 1.12eV, is weakly luminescent in the near-infrared region of the optical spectrum.

For porous Si, the luminescence peak energy from 1 .1 eV (infrared) to about 2.3 eV (green light), depends dopant conc. and type, current density during etch, duration of etch, and subsequent chemical treatment.

Qualitatively explained by invoking size-dependent quantum confinement. TEM supports the existence of crystalline Si domains small enough (ca. 5 nm) for this.

Other possible explanations: Structural or compositional changes occurring during electrochemical etch.

Suspension of porous Si crystals in toluene excited by He-Cd laser

M. J. Sailor, and Karen L. Kavanagh, Porous Silicon - What is Responsible for the Visible Luminescence?, *Adv. Mater.* **4** (1992) 432-434.

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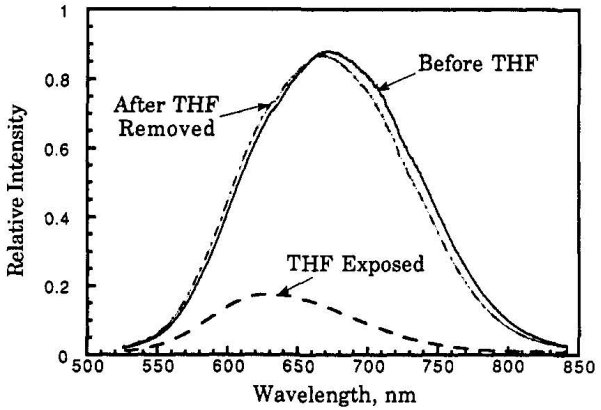

Figure 1. Emission spectra of luminescent porous Si sample before THF exposure (—), after 1 min of THF exposure (- - -), and after removal of THF under dynamic vacuum (–·–). Excitation source was the 442-nm line of a He/Cd laser (5 mW/cm^2).

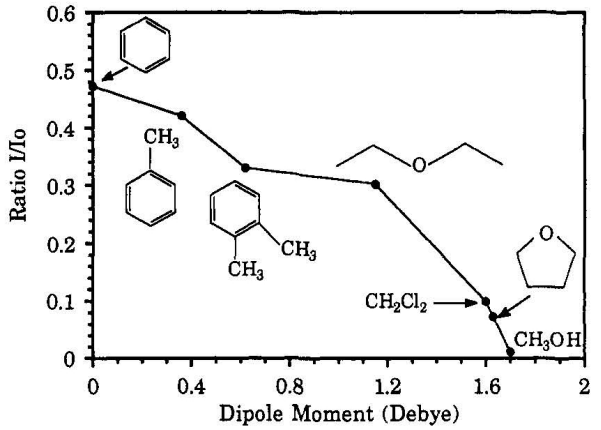

Figure 2. Correlation of the porous Si luminescence quenching ratio I/I_0 of the liquid solvents to their (gas phase) dipole moments.[11] The values determined for I/I_0 in (solvent) are as follows: 0.47 (benzene); 0.42 (toluene); 0.33 (*o*-xylene); 0.30 (diethyl ether); 0.11 (methylene chloride); 0.074 (tetrahydrofuran); 0.013 (methanol).

J. M. Lauerhaas, G. M. Credo, J. L. Heinrich, and M. J. Sailor, Reversible luminescence quenching of porous silicon by solvents, *J. Am. Chem. Soc.*, **14** (1992), 1911-1912.

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S. O. Meade, M. S. Yoon, K. H. Ahn, and M. J. Sailor, Porous silicon photonic crystals as encoded microcarriers,, *Adv. Mater.* **16** (2004) 1811-1814.

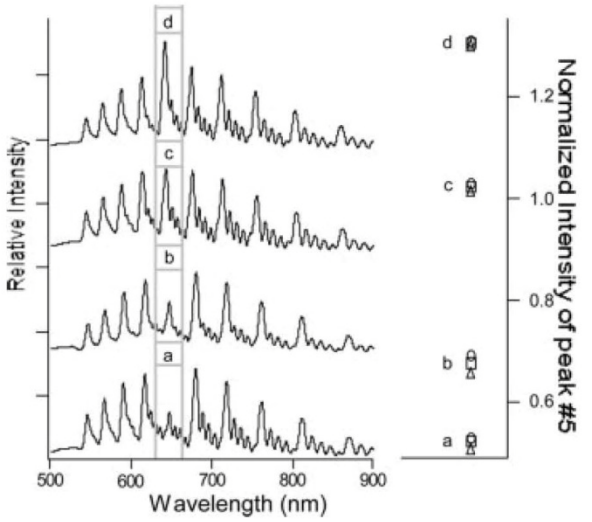
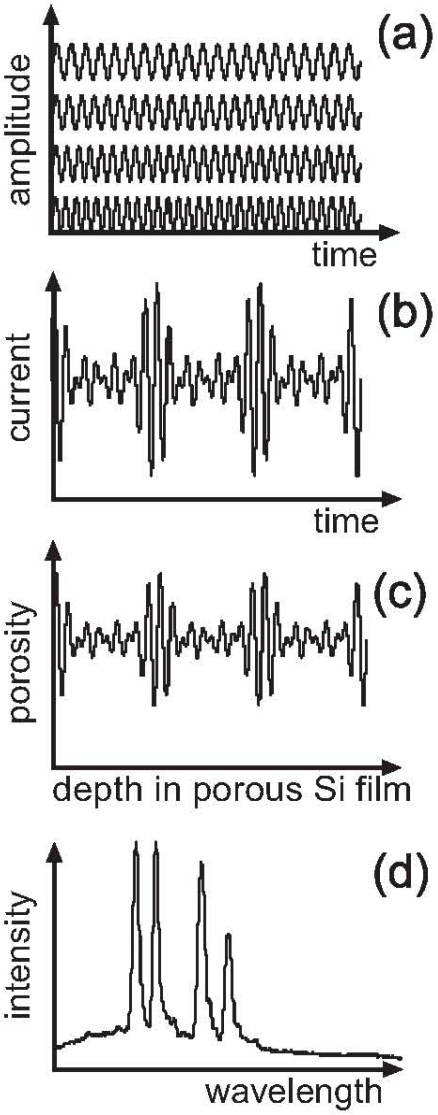


Figure 3. Use of relative peak intensity to carry coding information. Left plot displays four spectra of porous Si samples prepared using the parameters of Table 1, in which peak #5 in the spectrum (enclosed in the box, at approx. 650 nm) is varied over four discrete intensity values (a–d) relative to the rest of the spectrum. Plot at right shows the normalized intensity of peak #5 (relative to peak #6) for each of the four sample types a–d, as indicated. Three replicate samples were prepared for each of the four waveforms. Peak six is used as the reference peak. A total of four separate gray levels, or four states per bit, are shown. Spectra in the left plot are offset along the y-axis for clarity.



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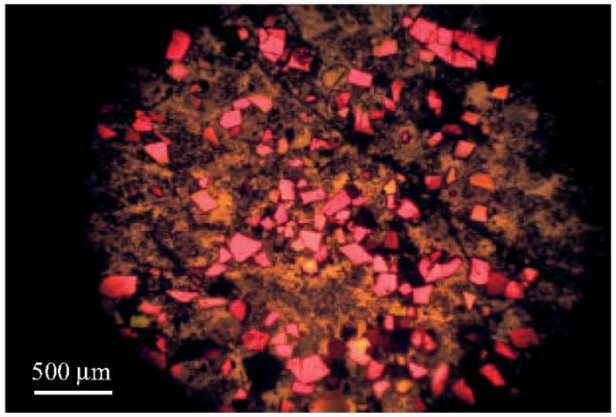

Fig. 1. Optical microscope image of the encoded nanostructured porous Si particles used in this study. The particles are being illuminated with a white light (tungsten) source. The particles were encoded with a Rugate structure to specifically reflect light with wavelengths of 630 ± 20 nm (in air).

T. A. Schmedake, F. Cunin, J. R. Link, and M. J. Sailor, Standoff detection of chemicals using porous silicon "smart dust" particles, *Adv. Mater.* **14** (2002) 1270-1272.

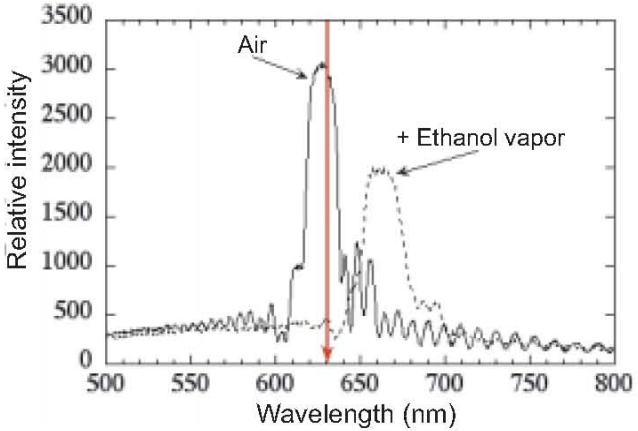

Fig. 2. Optical reflectivity spectrum of a single smart dust particle in laboratory air (solid) and in air containing ethanol vapor (dashed). The spectral position of the laser used to acquire the data presented in Figure 3 is shown for comparison (arrow).

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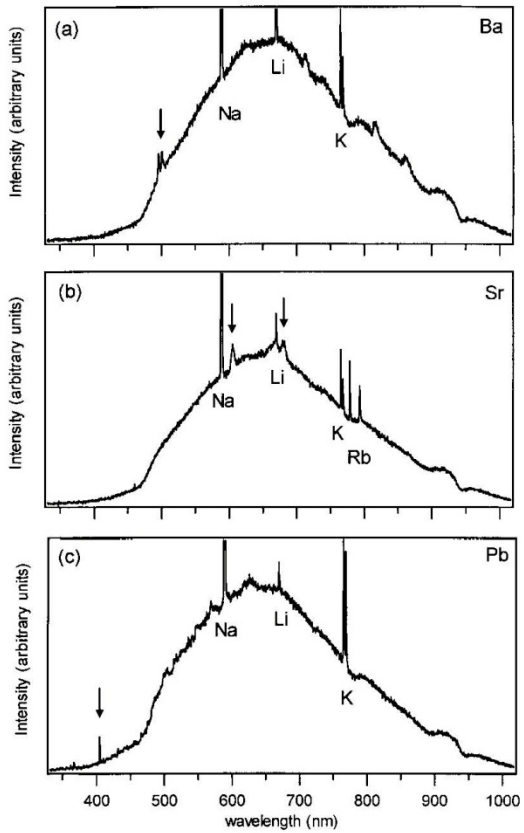

Fig. 4. Expanded spectra acquired from explosions of porous Si/nitrate samples that were treated with a) BaF_2, b) $Sr(NO_3)_2$, and c) $Pb(NO_3)_2$. Arrows indicate the peaks due to the analyte. Peaks due to alkali metal impurities are indicated below the spectra.

F. W. Mikulec, J. D. Kirkland, and M. J. Sailor, Explosive nanocrystalline porous silicon and its use in atomic emission spectroscopy, *Adv. Mater.* **14** (2002) 38-40.

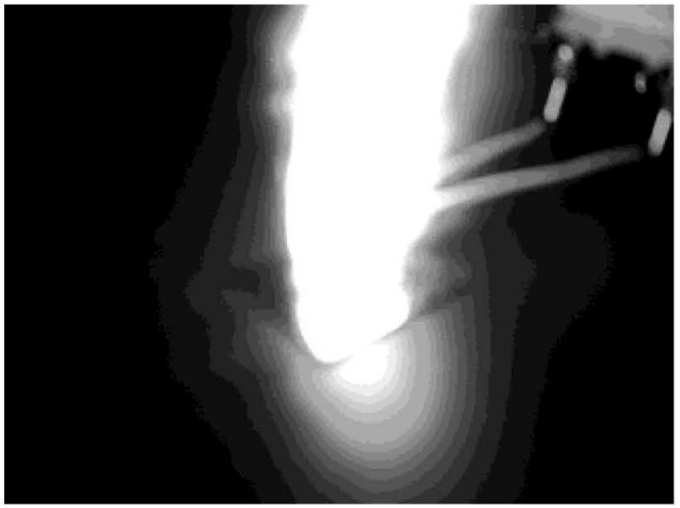

Fig. 1. Photograph of the bright light flash captured from the explosion of nitrate-treated porous silicon. Leads from a transformer (providing the spark) are visible in the upper right. The image is 5×8 cm^2.