Effect of thermal oxidation on the optically encoded porous silicon

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Thermal processing of mesoporous silicon nanostructures at high temperatures in ambient air results in irreversible changes in chemical composition, microstructure, and optical properties. The mesoporous silicon nanostructures are prepared as thin film and multilayer optical rugate filters by electrochemical etching of crystalline silicon in HF-containing electrolytes. The rugate filters are prepared using a current-time waveform consisting of a superposition of three sine waves, generating a one-dimensional photonic crystal that displays three stop bands in the visible reflectance spectrum. The thermal processing conditions involve partial or complete oxidation of the mesoporous Si skeleton to SiO2, and softening and flow of the resulting nanostructured oxide. The chemical and restructuring processes are followed by monitoring changes in optical reflectance, infrared, Raman, and powder X-ray diffraction spectra, water contact angle and porosity measurements, and by electron microscopy.