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# Nanocrystal characterization by ellipsometry in porous silicon using model dielectric function

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Porous silicon layers were prepared by electrochemical etching of *p*-type single-crystal Si (*c*-Si) of varying dopant concentration resulting in gradually changing morphology and nanocrystal (wall) sizes in the range of 2–25 nm. We used the model dielectric function (MDF) of Adachi to characterize these porous silicon thin films of systematically changing nanocrystal size. In the optical model both the surface and interface roughnesses have to be taken into account, and the $E_0$, $E_1$, and $E_2$ critical point (CP) features are all described by a combination of several lineshapes (two-dimensional CP, excitonic, damped harmonic oscillator). This results in using numerous parameters, so the number of fitted parameters were reduced by parameter coupling and neglecting insensitive parameters. Because of the large number of fitted parameters, cross correlations have to be investigated thoroughly. The broadening parameters of the interband transitions in the measured photon energy range correlate with the long-range order in the crystal. The advantage of this method over the robust and simple effective medium approximation (EMA) using a composition of voids and *c*-Si with a nanocrystalline Si reference [ Petrik et al., Appl. Surf. Sci. 253, 200 (2006) ] is that the combined EMA+MDF multilayer method of this work provides a more detailed description of the material and layer structure.



## Article Outline





KEYWORDS and PACS

**Keywords**

critical points, dielectric function, doping profiles, electrochemistry, elemental semiconductors, ellipsometry, etching, excitons, interface roughness, long-range order, nanostructured materials, porous semiconductors, semiconductor doping, semiconductor thin films, silicon, surface roughness, voids (solid)

**PACS**

**81.05.Cy**
Elemental semiconductors

**61.72.sd**
Impurity concentration

**61.72.Qq**
Microscopic defects (voids, inclusions, etc.)

**78.20.Ci**
Optical constants (including refractive index, complex dielectric constant, absorption, reflection and transmission coefficients, emissivity)

**68.35.bg**
Semiconductors

**71.35.-y**
Excitons and related phenomena

**68.55.ag**
Semiconductors

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