Elastic relaxation of porous silicon

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Structural properties of the porous silicon were studied by Raman scattering of the optical phonons. Self-supported porous silicon layers were prepared by electrochemical anodization using *p*-type boron doped silicon wafers. Different anodization currents provided for different degrees of porosity with characteristic sizes of tenths nanometers. In the samples with different porosity Raman scattering revealed the low-frequency and high-frequency lines caused by the longitudinal optical (LO) phonons of the amorphous and crystal phases respectively. The typical Raman scattering spectrum measured in one of the samples is shown in Fig.1(a).

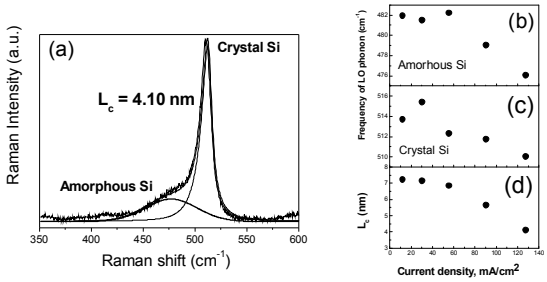

Fig.1. (a) Raman scattering measured at T = 10 K in the porous silicon sample produced at a current density of j = 128 mA/cm^2, thin lines are the results of the fitting; (b), (c) frequencies of the LO phonon measured in amorphous and crystal phases respectively and (d) localization length of the LO phonons obtained in porous silicon fabricated with different current densities.

The localization of the LO phonons in porous structure resulted in the asymmetry of the Raman line corresponding to the crystal Si. The phonon localization length (L_c) determined according to Ref.[1] demonstrated significant decrease with the increasing current indicating increasing degree of porosity. Moreover, the LO frequency of both the crystal and amorphous phases decreased with the current. This implies in a softening of the elastic properties of the porous silicon lattice with the increasing porosity. Thus, the nanoscale porosity causes relaxation of the elastic properties. The obtained experimental data are discussed in the frame of the model proposed in Ref.[2].

Keywords: porous silicon, Raman scattering, localization.

[1] Yu. A. Pusep, M. T. O. Silva, J. C. Galzerani, N. N. Moshegov, and P. Basmaji, Phys. Rev. B **58**, 10683 (1998).
[2] R.R.Koropecki, R.D.Arce, and J.A.Schmidt, Phys. Rev. B **69**, 205317 (2004).

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