Plasmonics for solar cell

From Appropedia

Contents

This page describes selected literature available on plasmonics for photovoltaics.

Effect of heavy doping on the optical properties and the band structure of silicon (http://prb.aps.org/abstract/PRB/v29/i12/p6739_1)[1]

Abstract: Author(s) have measured by ellipsometry the dielectric constant of pure and heavily doped n- and p- type silicon from 1.8 to 5.6 eV. Both ion-implanted laser-annealed and bulk doped samples were used with concordant results. A red shift of the E1 and E2 critical-point energies, together with a decrease in the excitonic interaction at the E1 energy, has been observed. These results are compared with first- and second-order perturbation-theory calculations of the effect of the impurities on the band structure of silicon.

Model dielectric constants of Si and Ge (http://prb.aps.org/abstract/PRB/v38/i18/p12966_1)[2]

Abstract: A method is described for calculation of the real (ε1) and imaginary parts (ε2) of the dielectric function of Si and Ge at energies below and above the fundamental absorption edge, in which the model is based on the Kramers-Kronig transformation and strongly connected with the electronic energy-band structure of the medium. A complete set of the critical points (CP's) are considered in this study. This model reveals distinct structures at energies of the E0, E0+Δ0 [three-dimensional (3D) M0], E1, E1+Δ1 (3D M1 or 2D M0), E2 [a mixture of damped harmonic oscillator (DHO) and 2D M2], E1', and E0' (triplet) CP's (DHO). The indirect-band-gap transitions also play an important part in the spectral dependence of ε2 of Si. Results are in satisfactory agreement with the experimental information over the entire range of photon energies. The strength and broadening parameters at energies of each CP are obtained and discussed.

Fundamental optical properties of heavily-boron-doped silicon (http://prb.aps.org/abstract/PRB/v36/i18/p9563_1)[3]

Abstract: Infrared-reflectivity data for B-ion-implanted and laser-annealed Si crystals are reported. In particular, the free-carrier response is analyzed by using the Drude relationships; new information both on the effective mass and scattering time is obtained in the presence of controlled amounts of disorder and a variable density of free holes. The free-carrier concentration is measured by means of the analysis of the x-ray intensity profiles obtained by double-crystal diffraction.

Optical properties of pure and ultraheavily doped germanium: Theory and experiment (http://prb.aps.org/abstract/PRB/v34/i4/p2586_1)[4]

Abstract: Author(s) have measured by spectroellipsometry the dielectric function ε of pure and ultraheavily doped germanium from the near-infrared (ħω≃1.6 eV) to the near-ultraviolet (ħω≃5.6 eV) regions. The dependence of the E1, E1+Δ1, E0', and E2 critical energies on impurity concentration was obtained. A red shift of the different critical-point energies, together with an increase of the lifetime broadening, has been observed. Amplitudes and phase angles for the corresponding critical points were also obtained. The results are compared with full band-structure calculations of the effect of the impurities on the band structure of germanium.

Dielectric functions and optical parameters of Si, Ge, GaP, GaAs, GaSb, InP, InAs, and InSb from 1.5 to 6.0 eV (http://prb.aps.org/abstract/PRB/v27/i2/p985_1)[5]

Abstract: Author(s) report values of pseudodielectric functions ⟨ε⟩=⟨ε1⟩+i⟨ε2⟩ measured by spectroscopic ellipsometry and refractive indices ñ=n+ik, reflectivities R, and absorption coefficients α calculated from these data. Rather than correct ellipsometric results for the presence of overlayers, Author(s) have removed these layers as far as possible using the real-time capability of the spectroscopic ellipsometer to assess surface quality during cleaning. Our results are compared with previous data. In general, there is good agreement among optical parameters measured on smooth, clean, and undamaged samples maintained in an inert atmosphere regardless of the technique used to obtain the data. Differences among our data and previous results can generally be understood in terms of inadequate sample preparation, although results obtained by Kramers-Kronig analysis of reflectance measurements often show effects due to improper extrapolations. The present results illustrate the importance of proper sample preparation and of the capability of separately determining both ε1 and ε2 in optical measurements.

Effect of heavy doping on the optical spectra of silicon (http://iopscience.iop.org/0256-307X/2/7/008/)[6]

Abstract: In this paper reflectance (R) and thermoreflectance (TR) spectra in heavily doped silicon concerning both interband and intraband transitions are reported and discussed. The heavily doped sample shows a red-shift and lifetime broadening in the two singularities E1(similar 3.4eV) and E2 (similar 4.5eV). The values of the scattering time τ extracted from the reflectivity fit are obtained and compared with those obtained from Hall mobility measurements.

Infrared surface plasmons on heavily doped silicon (http://jap.aip.org/resource/1/japiau/v110/i12/p123105_s1)[7]

Abstract: Conductors with infrared plasma frequencies are potentially useful hosts of surface plasmon polaritons (SPP) with sub-wavelength mode confinement for sensing applications. A challenge is to identify such a conductor that also has sharp SPP excitation resonances and the capability to be functionalized for biosensor applications. In this paper we present experimental and theoretical investigations of IR SPPs on doped silicon and their excitation resonances on doped-silicon gratings. The measured complex permittivity spectra for p-type silicon with carrier concentration 6×1019 and 1×1020 cm−3 show that these materials should support SPPs beyond 11 and 6 μm wavelengths, respectively. The permittivity spectra were used to calculate SPP mode heights above the silicon surface and SPP propagation lengths. Reasonable merit criteria applied to these quantities suggest that only the heaviest doped material has sensor potential, and then mainly within the wavelength range 6 to 10 μm. Photon-to-plasmon coupling resonances, a necessary condition for sensing, were demonstrated near 10 μm wavelength for this material. The shape and position of these resonances agree well with simple analytic calculations based on the theory of Hessel and Oliner (1965).

Infrared surface polaritons on antimony (http://www.opticsinfobase.org/oe/abstract.cfm?uri=oe-20-3-2693)[8]

Abstract: The semimetal antimony, with a plasma frequency ~80 times less than that of gold, is potentially useful as a host for infrared surface polaritons (SPs). Relevant IR SP properties, including the frequency-dependent propagation length and penetration depths for fields into the media on either side of the interface, were determined from optical constants measured on optically-thick thermally-evaporated Sb films over the wavelength range 1 to 40 μm. Plasma and carrier relaxation frequencies were determined from Drude-model fits to these data. The real part of the permittivity is negative for wavelengths beyond 11 μm. Distinct resonant decreases in specular reflected intensity were observed for Sb lamellar gratings in the wavelength range of 6 to 11 μm, where the real part of the permittivity is positive. Both resonance angles and the angular reflectance spectral line shapes are in agreement with theory for excitation of bound surface electromagnetic waves (SPs). Finite element method (FEM) electrodynamic simulations indicate the existence of SP modes under conditions matching the experiments. FEM results also show that such waves depend on having a significant imaginary part of the permittivity, as has been noted earlier for the case of surface exciton polaritons.

Optical functions of ion-implanted, laser-annealed heavily doped silicon (http://prb.aps.org/abstract/PRB/v52/i20/p14607_1)[9]

Abstract: The optical functions of silcon heavily doped with Ge, P, As, and B are determined using spectroscopic ellipsometry measurements from 240 to 840 nm (5.16 to 1.47 eV). Below the direct band gap, there is a residual enhancement of the optical-adsorption coefficient for silicon heavily doped with n-type dopants, which cannot be explained by surface roughness. In the low-energy region of the observed spectrum, it is found that both free-carrier and strain effects alter the complex dielectric function.

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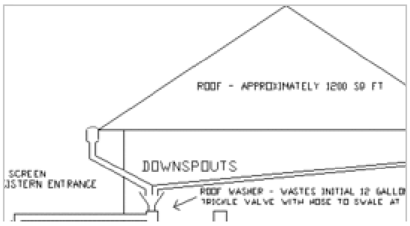

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