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Review
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Detailed computer modeling of semiconductor devices

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Abstract : Detailed computer modeling to optimize the performance and design of semiconductor devices in general and of solar cells in particular has become extremely popular over the last two decades. This is because, experimentally, such optimization involves a huge number of trials; whereas the number of trials needed to optimize the performance of such semiconductor devices, can be decimated, using computer modeling, which is nowadays therefore widely recognized as a tool for faster progress of such research. A detailed computer model, as opposed to simple analytical models, is where the Poisson's equation and the electron- and hole-continuity equations are all solved from the first principles, without resorting to any simplifying assumptions. It is therefore, only such detailed models that are capable of giving an insight into device performance. Such models become very complicated in the case of disordered semiconductors, where we also have to take into account the trapping and recombination kinetics through the gap states. Moreover, in order to model both the electrical and optical properties of opto-electronic devices based on semiconductors in their entirety, we also need to combine the electrical model with a suitable optical model, capable of calculating not only the absorption in each portion of the device, but also the losses suffered by reflection or absorption in the non-active layers of the device. Moreover, diffused reflectance, transmittance and absorption when the device is deposited on a textured or rough surface also need to be taken into account; as also specular interference effects when the interfaces are flat. In this review, we will discuss a detailed electrical-optical model that is capable of modeling the performance of a general *n*-layer device based on crystalline, amorphous, poly-, micro- or nano-crystalline semiconductor, with particular reference to the modeling of opto-electronic devices, such as solar cells and color sensors.

Keywords : Detailed computer modeling, amorphous and disordered semiconductors, solar cells, electrical model, optical model, gap-state model.

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A study of refractive index structure constant from radar data

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Abstract : The work focuses on the measurement of refractive index structure constant from the backscattered signal strength. For this purpose, I have made use of the equatorial data measured by medium frequency (1.98 MHz) Partial Reflection Radar, located at Tirunelveli (8.7°N, 77.8°E, 0.3°N magnetic dip.). This radar has been operated continuously by the Indian Institute of Geomagnetism; the data obtained with this radar have been providing valuable information on middle atmosphere dynamics. This is a preliminary study conducted in the equatorial region and the Partial Reflection Radar is not an efficient tool for turbulent studies, hence the estimation of refractive index structure constant of turbulence *i.e.* C_n^2 is very difficult. The refractive index structure constants for turbulence is calculated numerically and plotted with the vertical wind velocity. C_n^2 values show an enhancement during post sunset hours. It may be due to the fact that the plasma within the geomagnetic flux tube becomes unstable because of pre-reversal enhancement ($\boldsymbol{E} \times \boldsymbol{B}$ electrodynamic drift) and takes part in the up-welling process thus making turbulence within the volume.

Keywords : Refractive index structure constant, turbulence, radar data.

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Relative backscattering yields for electrons and positrons from tungsten at keV energies

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Abstract : The backscattering coefficients (η_0^-, η_0^+) and their ratios for impact of 8–28 keV electrons and positrons with a thick tungsten target at normal incidence, have been determined and compared with the available data on W and Au targets. It is found that the backscattering ratios attain a constant value of about 1.35 at higher impact energies while they are seen to rise significantly at the lower impact energies. The measurements of backscattering yields at three different scattering angles, namely, at θ = 110°, 120° and 130° for normal incidence of 8 keV electrons with a thick tungsten target, have been made. The measured relative yields are studied as a function of θ and they are compared with the available data from other workers. The compared data are found to be in good agreement with each other and to follow a well known Lambert's cosine-law within the experimental uncertainty of measurements.

Keywords : Backscattering yields, stopping power, scattering cross section, electron/positron impact.

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Investigation of antimony addition on the glass transition kinetics of $Se_{80}Te_{20-x}Sb_x$ using calorimetric measurements

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Abstract : Calorimetric measurements have been performed in glassy alloys $Se_{80}Te_{20}$ and $Se_{80}Te_{20-x}Sb_x$ (x = 0.5 and 1) to study the effect of the lower concentration of antimony additive on the kinetics of glass transition in glassy $Se_{80}Te_{20}$ alloy. The variation of T_g with heating rate and composition has also been studied. The heating rate dependence of T_g is used to evaluate the activation energy of glass transition.

The thermal stability of these glasses has also been discussed. It has been found that thermal stability increases on addition of Sb in glassy $Se_{80}Te_{20}$ system. This increase is explained in terms of decrease in activation energy of glass transition.

Keywords : Chalcogenide glasses, differential scanning calorimetry, glass transition kinetics, thermal relaxation.

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Thermodynamic properties of liquid AlMg alloys

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Abstract : A statistical thermodynamic theory in conjunction with the complex formation model, has been used to investigate the thermodynamic properties of liquid AlMg alloys. Thermodynamic properties such as free energy of mixing, heat of mixing and entropy of mixing have been reproduced by our expressions. Concentration-concentration fluctuations at the long-wavelength ($S_{cc}(0)$) limit have been obtained to investigate the stability and structural information about liquid AlMg alloys. The study of chemical short range order parameter (α_1) has been carried out to quantify the degree of order. The study reveals that liquid AlMg alloy is a weak interacting system. It is to mention that various factors such as size difference and electronegativity difference are too small to account for the asymmetric behaviour in this system. The observed asymmetry suggests that Al_3Mg_2 complexes are formed in the liquid AlMg alloy.

Keywords : Liquid AlMg alloys, thermodynamic properties, concentration fluctuations, chemical short range order, electronegativity.

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FTIR absorption spectra and thermodynamic functions of 5-chloro-2,3-dihydroxy pyridine

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Abstract : The infrared absorption spectra of 5-chloro-2,3-dihydroxy pyridine have been recorded in the region 400 – 4000 cm^{-1}. The bands observed in the IR spectra are discussed by assuming the compound under C_s point group symmetry. The modes of vibration for the different fundamentals have been proposed. The thermodynamic functions have also been calculated by using IR frequencies at different temperatures with the help of computer programming.

Keywords : Infrared and Raman spectroscopy, vibrational frequencies, thermodynamic functions.

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Leptonic CP violation and neutrino mass in a three generation $SU(2)_H$ gauge model

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Abstract : We have shown that with suitable Higgs field the lepton mass matrix in $SU(2)_L \times SU(2)_R \times U(1)_{B-L} \times SU(2)_H$ gauge model is identical with the mass matrix *ansatz* based on the permutation symmetry. The possibility of leptonic CP violation is discussed in terms of CP-violating rephasing-invariant quantity J^l_{CP}. The neutrino mass bounds are also mentioned on the basis of the mass matrix obtained.

Keywords: CP Violation, neutrino mass, horizontal symmetry.

PACS Nos. : 14.60.Pq, 11.30.Er, 11.30.Hv

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Semiclassical statistical mechanics of two dimensional hard-body fluid mixtures

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Abstract : The theory is developed to derive the thermodynamic properties of the two dimensional (2D) semiclassical hard convex body (HCB) fluid mixtures. Analytic expressions are given for the thermodynamic properties and virial coefficients for the 2D HCB fluid mixtures. The numerical results are discussed under the conditions : (i) $\sigma_{11}^{o} = \sigma_{22}^{o}$ and (ii) $v_1 = v_2$. The first order quantum corrections are also studied. The quantum effects depend on the conditions, shape parameters L_{11}^{*}, L_{22}^{*} and concentrations x_1, x_2 in general, and increase with the increase of packing fraction η in particular.

Keywords : Hard-body fluid mixture, thermodynamics, quantum correction.

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Critical points in electron – Zn atom elastic scattering

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Abstract : Partial wave method along with a complex, energy dependent, local and central optical potential is employed to get the critical points for the electron – Zn atom elastic scattering. At critical points E_c = 486.3 eV and Θ_c = 124.5°, the differential cross section attains a value of $4.488 \times 10^{-6}\ a_0^2 \mathrm{Sr}^{-1}$. About 80% spin polarization of scattered electron beam is obtained at angles 124.1° and 124.8° for the critical energy E_c.

Keywords : Critical points, electron, Zn atom, differential cross section, spin polarization.

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Temperature dependence of adiabatic elastic moduli of $(Mg_{1-x}, Fe_x)_2SiO_4$

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Abstract : In the present work, we investigate the temperature dependence of the bulk modulus and shear modulus of olivine minerals with different compositions. The calculations are performed with the help of high pressure-high temperature equation of state based on thermodynamic analysis. The anharmonic term arising due to thermal expansion, has been taken into account in the expansion of logarithmic series of the thermodynamic data. The results obtained for two olivines *viz.* $(Mg_{1-x}, Fe_x)_2 SiO_4$ with $x = 0.08$ and $x = 0.10$ are discussed and compared with the experimental data. The excellent agreement with the experimental data is achieved.

Keywords : Equation of state, elastic moduli, olivines, bulk modulus.

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Charge decay characteristics of polystyrene

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Abstract : The charge decay behavior of polystyrene (PS) samples, ≈ 40 μm in thickness, was investigated by means of transient currents (in charging and discharging mode) and thermally stimulated discharge currents (TSDC) measurements as a function of polarizing fields, and temperatures. The order of currents has been found to increase with increasing these parameters. The current-time characteristics have different values of slopes lying between 0.45 to 0.65 and 1.66–1.99. The TSDC thermograms of PS consist of a peak located around 60−85°C. Comparative studies of the isochronal characteristics (*i.e.* current-temperature plots at constant times) with the thermally stimulated discharge current, indicated a strong resemblance between two techniques. It is suggested that both the dipolar orientation due to molecular mechanism of motions with the side chains and space charges due to trapping of injected charge carriers in energetically distributed traps may be responsible for the observed currents.

Keywords : Charge decay, transient currents, thermally stimulated discharge currents, dipolar orientation, space charge mechanism.

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