

MgB₂ superconductor : a review

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Abstract : Synthesis, structure and properties of the most intensively studied newly discovered intermetallic binary superconductor MgB₂ have been reviewed up to October, 2002. Though this material was known since 1950s, it was recently discovered to be superconductive with a record high $T_c \sim 40$ K. The detection of this binary superconductor by a Japanese research group in January, 2001 initiated the basic research to find out other binary and ternary intermetallic superconductors like TaB₂, BeB_{2.75}, MgCNi₃ etc. It has a hexagonal unit cell with cell parameters $a \sim 3.1432$ Å and $c \sim 3.5193$ Å. MgB₂ bulk samples synthesized under high pressure (~ 3.5 GPa) and high temperature (~ 1000 °C) has density ~ 2.63 g/cm³. The normal state carriers of MgB₂ are holes which have been established from the positive thermoelectric power and Hall coefficient measurements. The external pressure decreases the critical temperature (T_c) with dT_c/dP in the range of -1 to -2 K/GPa. The T_c decreases rapidly by the doping of Mn, Li, Co, C, Al, Ni and Fe but increases slightly by Zn doping. However, no significant change of T_c is observed by the doping of Si and Be. It is further noticed that the anisotropic ratio $g (= H_{c2}^{ab}/H_{c2}^c) \sim 1-5$ with lower critical field (H_{c1}) $\sim 25-48$ mT and upper critical field, $H_{c2}(0) \sim 40$ T. The critical current density (J_c) of it is as high as 1.3×10^6 Acm⁻² in the self-field and 9.4×10^4 Acm⁻² in a magnetic field of 2 T at the temperature of 20 K. The most interesting feature of this superconductor is the appearance of two superconducting energy gaps one $D_1 \sim 1.92$ meV and the other at $D_2 \sim 3.45$ meV. From theoretical studies, it is found that MgB₂ superconductor has a minimum of the density of states (DOS) just above the Fermi level which can account for the decrease of T_c with the increase of pressure. This review mainly deals with experimental results obtained by different research groups working on this new superconductor. Since more new and interesting results are expected in near future, critical theoretical analysis of the existing experimental data has not been made. We hope to do this work in our next review on this subject.

Keywords : MgB₂, superconductivity, synthesis, structure, applications

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GA based parameter optimizations for better millimeter and sub-millimeter wave response characteristics of GaAs quantum wells

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Abstract : The aim of this work is to predict the optimum values of the system parameters of GaAs quantum wells incorporating the relevant scattering mechanisms for getting better millimeter and sub-millimeter wave response characteristics and to explore the possibilities of new applications of such nanostructures. Optimized parameters have been computed by employing the Genetic Algorithms to get the desired response as an aid to the device related work. The optimized parameters like phase angle, ac mobility, channel width, carrier concentration, lattice temperature and electron temperature will obviously save the search time for the technologists involved in the fabrication of devices.

Keywords : Genetic algorithm, optimization, quantum wells, ac mobility, hot electron, probabilistic rules, carrier transport.

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Threshold switching effects in amorphous CuInSeS thin films

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Abstract : The switching effects in amorphous CuInSeS thin films have been investigated. The amorphous CuInSeS thin films were obtained by thermal evaporation of the polycrystalline materials under vacuum of about 10^{-6} Torr and with evaporation rate about 80 Å/ sec. The annealing of the films at different annealing temperature improves the switching characteristics and decreases the threshold voltage V_{th} . The threshold switching voltage and threshold activation energy E_s were found to decrease linearly with increasing annealing temperature and decreasing with thickness. Moreover, the threshold switching voltage increased exponentially with temperature.

Keywords : Amorphous semiconductor, CuInSeS thin films, threshold switching effects

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Growth of praseodymium samarium hydrogen selenite mixed crystals and their characterisation

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Abstract : Following chemical reaction method, mixed crystals of praseodymium samarium hydrogen selenite were grown in silica gel by single diffusion method. The difference in growth features by varying different growth parameters was studied in detail. Optimum growth conditions yielded good quality crystals of praseodymium samarium hydrogen selenite (PSHS). These crystals were characterised by X-ray, UV-Visible and infrared spectroscopic methods. The energy dispersive analysis by X-rays was utilised to find the percentage of praseodymium and samarium ions in the grown crystals. The unit cell parameters of the crystals were obtained from single crystal and powder X-ray diffraction techniques. The molecular formula of the crystals was clarified with TG in complement with infrared study. The micro-indentation studies were carried out to study the hardness of well faceted PSHS crystals.

Keywords : Rare earth crystals; crystal growth; spectroscopic studies; thermogravimetric studies; microhardness.

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Micro hardness studies of pure and doped brushite crystals

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Abstract : Vicker's micro hardness studies on pure and doped brushite ($\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$) crystals are reported. The micro hardness value (H_v), work hardening coefficient (n), and first order elastic stiffness coefficient (C_{11}) are reported for brushite crystals doped with Ni, Cd Mg and Pb. It has been observed that the micro hardness has a load dependent part and a load independent part.

Keywords : Urinary stones, doped brushite crystals, Vicker's micro hardness.

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Flyash : A radiation shielding material

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Abstract : To support the use of flyash material as a radiation shielding material for gamma or X-rays, the radiation interaction parameters (attenuation coefficients and buildup factors) have been studied as a function of incident photon energy. The attenuation coefficients are found to have large values in low and high energy region whereas the buildup factor values have a maxima in the medium energy region. These variations in attenuation coefficient as well as in the buildup factor in different energy regions, have been interpreted in terms of Z-dependence of partial photon interaction processes and have been presented in the form of graphs.

Keywords : Flyash, radiation shielding material, interaction parameters.

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Comparative study of mixed product and quaternion product

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Abstract : Mixed number is the sum of a scalar and a vector. The quaternion can also be written as the sum of a scalar and a vector but the product of mixed numbers and the product of quaternions are different. Here, we studied the mixed product which is derived from the product of mixed numbers and the quaternion product which is derived from the product of quaternions. It was observed that mixed product is more consistent with Physics than that of quaternion product.

Keywords : Mixed number, mixed product, quaternion product

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Application of MCNP code to shielding analysis for single and multilayers of polyethylene and lead

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Abstract : Calculations were made using MCNP-4B code to study the neutron shielding effectiveness of polyethylene (PE) and lead (Pb) as a single and multilayer arrangements against U^{235} fission neutron source. Shielding slabs of 5 cm thickness were employed successively. Transmission factors for the above-mentioned shielding setups were determined upto 100 cm thickness. Dose spectra have been calculated for different thicknesses of the shielding arrangements. The results revealed that using slabs successively of 15 cm PE plus 15 cm Pb is as efficient in shielding fission neutrons as using of 30 cm PE shield alone. It was also found that after 40 cm shield thickness, the removal cross section values of the multilayers and single PE shield are not very much different, and are approaching each other with increasing shield thickness.

Keywords : MCNP, polyethylene, lead, neutron shielding

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A study of absolute hardness of some organic molecular solids

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Abstract : The absolute hardness is defined as the hardness number independent of the applied load. An evaluation has been made of the absolute or true hardness values for the organic solids anthracene, phenanthrene and carbazole using both the Knoop and Vickers microhardness *versus* load data. The results obtained by graphical analysis agree very well with the calculated results, within experimental error. The present note reports the results obtained, using the method utilizing the extrapolation function.

Keywords : Knoop microhardness, Vickers microhardness, organic molecular solids

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Absolute hardness of phenanthrene doped anthracene single crystals by Knoop indentation technique

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Abstract : The absolute hardness value of anthracene doped with phenanthrene using Knoop hardness technique has been obtained. The absolute hardness is defined as the hardness which is not load dependent. The results obtained by graphical analysis compare well with the calculated results, within experimental error. The present note reports the results obtained, using the method utilizing the extrapolation function. The higher absolute hardness of the phenanthrene doped anthracene is due to the molecular hindrance to slip.

Keywords : Absolute hardness, Knoop indentation, doped anthracene

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Fragmentation in S^{32} -AgBr interaction at 200 GeV/n – evaporation model revisited

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Abstract : This paper presents new data target fragment model in S^{32} -AgBr interaction at 200 GeV/n. The data do not favour evaporation model instead a preferential backward emission of black track is indicated by the data.

Keywords : Nucleus-nucleus interaction, evaporation model, backward emission

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