

Stimulation of ice crystallisation with ultrasonic cavitation – microscopic studies

Rachel Chow^{1*}, Renoo Blindt¹, Arnold Kamp², Peter Grocutt² and Robert Chivers³

¹Unilever Research & Development, Colworth House, Sharnbrook, Beds MK44 1LQ, United Kingdom

²Linkam Scientific Instruments, 8 Epsom Downs Metro Centre, Tadworth KT20 5HT, United Kingdom

³DAMTP, University of Cambridge, CB3 9EW, United Kingdom

E-mail : Rache. Chow@Unilever.com

Received 16 December 2002, accepted 8 January 2003

Abstract : While the Capability of ultrasonic waves to stimulate crystallisation in various liquids has known for over 70 years, controlled experiments on the crystallisation of water are almost unknown, as are reports on the direct visualisation of the processes involved. The difficulty of setting up the experiments has been the major factor in the failure to date to identify the mechanisms involved in the sonocrystallisation of water. This report describes the first direct observations of the influence of ultrasonic cavitation on the production of secondary nuclei of ice from dendritic crystals. It has been achieved using a novel microscope measurement stage that not only permits controlled heating and cooling of the specimen, but also its simultaneous excitation with alternating pressures in the ultrasonic frequency range. Three distinct new phenomena have been observed to date. Firstly, there is a tendency for cavitation bubbles to form at the grain boundaries between the (hexagonal) crystals in the ice. Secondly, there is a process whereby the bubbles appear to eat their way into the ice, melting it as they progress; and thirdly, the dendritic structures are fragmented, thus multiplying the number of crystal nuclei in solution (secondary crystallisation).

Keywords : Crystallisation, ice, ultrasonics, microscopy.

PACS Nos. : 64.70.Dv, 43.35.+d, 68.37.Tj

A structural analysis of the effect of Ar and H₂ on microcrystalline growth in Si : H materials deposited in conventional PECVD chamber

Namita Dutta Gupta and Partha Choudhuri*

Energy Research unit, Indian Association for the Cultivation of Science, Jadavpur, Kolkata-700 032, India

E-mail : erpc@mahendra.iacs.res. in

Received 25 March 2003, accepted 2 April 2003

Abstract : Evolution of Hydrogen content and bonding have been studied in two sets of Si : H samples deposited near the amorphous (a-Si : H)-microcrystalline (μ c-Si : H) boundary from hydrogen (H₂) and argon (Ar)-diluted silane (SiH₄) by varying the *rf* power in conventional (13.56 MHz) plasma enhance chemical vapour deposition (PECVD). Microcrystallinity in the samples was verified by transmission electron microscopy (TEM). In H₂-diluted μ c-Si : H samples, the selective etching of SiH₂ by atomic hydrogen from the grain boundary has been observed. On the other hand in Ar-diluted samples, SiH₂ mode absorption increases with increase of *rf* power. Appearance of the infrared absorption peak around 2030 cm⁻¹ in both H₂ and Ar-diluted samples, indicates that the platelet like configuration of Si–H bond may be associated with the growth of microcrystalline grains. Role of the metastable Ar* in the growth of μ c-Si : H has been discussed.

Keywords : Microcrystalline silicon, Fourier Transform infrared spectroscopy, transmissio electron microscopy.

PACS Nos. : 68.55.-a, 68.37.Lp, 78.30.Ly. 33.20.Ea

Growth and microhardness studies in solution-grown single crystals of thenardite

S Karan and S P Sen Gupta*

Department of Materials Science, Indian Association for the Cultivation of Science, Jadavpur, Kolkata-700 032, India

E-mail : msspsg@iacs.res.in

Received 16 April 2003, accepted 25 April 2003

Abstract : Single crystals of Thenardite (Sodium Sulphate Na_2SO_4) were grown by slow evaporation technique at room temperature. Mechanical characterization was done by Vickers microhardness testing. Load varying from 10 to 120 g was applied on selected (011) faces over a fixed interval of 10 seconds. Vickers hardness number (H_v) were found to decrease with increase in load. Meyer index ' n ' was found to be less than 2 as expected and thus the particular crystal system belongs to soft material category. Neither Kick's law nor Hays and Kendall's law can satisfactorily explain the nonlinear variation of microhardness with load. Instead, it was best explained by Li and Bradt's Proportional Specimen Resistance (PSR) model. Crack lengths were measured and found to increase with load. The fracture toughness values (K_{IC}) were estimated to be 0.227 and 0.151 $\text{MNm}^{-3/2}$ for (011) faces at 100 and 120 g respectively. The Brittleness indices (B_i) were determined as 1.455 and 3.297 $\text{mm}^{-1/2}$ respectively for the same faces at the same loads. Using Wooster's empirical relation, elastic stiffness coefficient, c_{11} has been calculated from hardness data.

Keywords : Thenardite, growth from solution, hardness, Meyer index, brittleness.

PACS Nos. : 81.10.Dn, 62.20 Qp, 62.20.Mk

Photoemission study of Ba 2+ and Nd 3+ substitution for Ca 2+ in the BSCCO (2212) superconducting system

Kamlesh Kumari¹, R K Singhal¹, K B Garg^{1*}, M Heinonen², J Leiro², Anurag Gupta³ and S K Agarwal³

¹Condensed Matter Physics Laboratory, Department of Physics, University of Rajasthan Jaipur-302 004, Rajasthan, India

²Applied materials Science Laboratory, Department of Physics, University of Turku, 20014-Turku, Finland

³National Physical Laboratory, CSIR Complex Pusa Road, New Delhi-110 012, India

E-mail : krish35@sancharnet.in

Received 19 June 2002, accepted 8 April 2003

Abstract : The photoemission measurements have been carried out on the BSCCO (2212) superconducting system to understand the effect of substitution of trivalent impurity (Nd) for divalent Ca and the effect of substitution Ba that has a larger ionic radius than Ca. The two compounds have been characterized by XRD and resistivity measurements. The photoemission measurements have been made on the Bi 4*f*, Sr 3*d* and Ca 2*p* core levels. The core level spectra show some changes – their binding energies and fine structure – due to substitution in the two cases – which will be discussed in detail.

Keywords : Photoemission, cuprate superconductors, core levels, valence band, BSCCO.

PACS Nos. : 79.60.Jv, 74.72.Hs

Theory of Auger neutralization of positrons at metal surfaces

Adbalaziz A Almulhem

Department of Physics, King Faisal University, P.O. Box 9149, Al-Ahssa, 31982, Saudi Arabia

E-mail : aalmulhem@kfu.edu.sa

Received 12 September 2002, accepted 8 January 2003

Abstract : The transition rate in the process of positron neutralization *via* Auger mechanism during scattering from metal surfaces is studied. In this mechanism, a positron is neutralized by picking up an electron while another electron picks up enough energy to escape the potential barrier at the surface. A unitary transformation is introduced to the second quantized Hamiltonian. The bound state is described by a state orthogonal to all conduction band states of the metal. The theory is applied to the case of a positron, capturing an electron from aluminum surface while an Auger electron is released. The neutralization rate is calculated as a function of distance from the surface. The transition rate for neutralization decays exponentially with distance from the surface. The general behavior is similar to the ion neutralization at metal surfaces.

Keywords : Positron neutralization, positron-solid interaction, Auger neutralization.

PACS Nos. : 78.70.Bj, 79.20.Rf, 79.20.Fu

Rapid determination of quartz and structural characterisation of feldspars in rocks using FTIR

V Ramasamy*, K Anandalakshmi and V Ponnusamy

Department of Physics, Annamalai University, Annamalai nagar-608 002, Tamil Nadu, India

E-mail : srsaranram@rediffmail.com

Received 20 September 2002, accepted 16 December 2002

Abstract : An infrared absorption method has been used to identify components (minerals) of rocks collected from various areas of Tamil Nadu without pre-treatments other than air drying and grinding and consequently with no significant modification of constitution that may occur with other conventional methods of examination requiring extensive pre-treatments. The results obtained from the IR absorption spectra show the presence of quartz, feldspars, gibbsite, illite, maghemite, magnetite, hematite, kaolinite, vermiculite and palygorskite minerals. The quality of the quartz mineral is substantiated by calculating the crystallinity index. The relative distribution of quartz among the various sites are determined using extinction coefficient of the characteristic peak at 780 cm^{-1} . The quartz present in the samples from the site number 7 is in relatively well crystalline form than others. The presence of sanidine feldspars offers information on the temperature and pressure during the formation of rock resulting in Al/Si disorder.

Keywords : FTIR, mineral identification, quartz and feldspars.

PACS Nos : 61.66.Fn, 78.30.Hv, 42.70.Ce, 91.60 Ed

DC electrical conduction mechanism in polypropylene–Bijoypur White caly (PP-BWC) composites

A Razzak and A H Bhuiyan*

Department of Physics, Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh

E-mail : abuiyan@phy.buet.ac.bd

Received 5 September 2002, accepted 24 March 2003

Abstract : Polypropylene-Bijoypur white clay (PP-BWC) composites were prepared at different compositions of PP and BWC of Bangladesh by extrusion technique. Structural change was investigated using X-ray diffractometry (XRD). The dc electrical conduction mechanism of different PP-BWC composites was studied by current-voltage (I – V) characteristic measurements. It is observed that Poole-Frenkel type of mechanism is operative in these materials. The dc conductivity measurement of the different samples was performed in the temperature range 298 K to 400 K. The temperature dependence of electrical conductivity indicates that the conduction is due to thermally activated hopping of charge carriers.

Keywords : Polypropylene-Bijoypur white clay composites. X-ray diffractometry, dc electrical properties.

PACS Nos. : 61.41.+e, 72.80.Tm, 61.10.Nz

Effect of Zn dilution on the electrical properties of $\text{Co}_{1-x}\text{Zn}_x\text{La}_y\text{Fe}_{2-y}\text{O}_4$ ($0.1 \leq x \leq 0.9$ and $y = 0.25$)

G Abdellatif

Department of Physics, Faculty of Science, Cairo University, Giza, Egypt

E-mail : moala47@hotmail.com

Received 14 August 2002, accepted 13 February 2003

Abstract : The AC conductivity, dielectric constant ϵ' and dielectric loss factor ϵ'' were measured for the ferrite samples $\text{Co}_{1-x}\text{Zn}_x\text{La}_y\text{Fe}_{2-y}\text{O}_4$ ($0.1 \leq x \leq 0.9$ and $y = 0.25$) prepared by standard ceramic technique. X-ray and IR analysis were carried out to assure the formation of the spinel samples. The measurements were performed at different temperatures from 300 K upto =800 K. The conductivity results were discussed on the basis of hopping mechanism of electrons and holes where the activation energy values are in the semiconducting region. The electron exchange between the different cations in the same equivalent lattice sites or in different sites, plays a role in the conductivity behaviour.

The measurements of the dielectric constant ϵ' reveals a decrease with the increase of both frequency and Zn-content. The optimum condition of the critical concentration was $x = 0.7$. The decrease in viscosity and lattice vibration as well as the phonon generation, help in increasing energy dissipation and in turn ϵ'' .

Keywords : Ferrite samples, electrical properties, composition and temperature dependence.

PACS Nos. : 72.15.Eb, 75.50.Gg, 72.20.Ee

Temperature dependence of junction voltage in bilayer cuprate superconductors

M P Singh

Department of Physics, G B Pant University of Technology, Pantnagar-263 145, Uttaranchal, India

E-mail : mahipalsingh@rediffmail.com

Received 6 September 2002, accepted 26 March 2003

Abstract : The present work deals with the study of junction voltage as a function of temperature and various microscopic interactions that exist in bilayer high temperature cuprate superconductors. For this purpose, a tight binding bilayer Hubbard Hamiltonian has been considered that includes the in-plane (within CuO_2 Plane) and out-of-plane interactions. The situation for bilayered cuprates considered here is equivalent to a Josephson's coupled SIS junction. We rely on the Green's function equations of motion approach within simple BCS formalism and derive the expressions for superconducting order parameter, carrier density and junction voltage. The numerical analysis shows that in bilayer cuprates, the junction voltage depends on various in-plane and out-of-plane contributions as well as on temperature. Finally, we have compared our theoretical results on junction voltage with that of existing experimental results and found to be in qualitative agreement.

Keywords : Bilayer high- T_c cuprates, Josephson effects, junction voltage.

PACS Nos. : 74.72.Bk, 74.50.+r, 74.78.Fk

Irradiated polytetraflouroethylene (PTFE) and polyethylene (PE) microstructural changes studied by PAL technique

A A Al-Bayati

Department of Physics, College of Science, University of Baghdad, Baghdad, Iraq

Received 5 February 2002, accepted 25 March 2003

Abstract : Position annihilation lifetime (PAL) technique has been employed to study the microstructural changes of PTFE and PE due to irradiation at low doses of neutrons $(5-5.01) \times 10^{-2}$ Gy. The size of the free volume holes and their fraction in PE and PTFE were determined from ortho-positronium lifetime component and its intensity in the measured lifetime spectra. The results show that this range of irradiation causes significant changes in the free volume hole sizes (V_h) and the fractional free volume (F_h), and thereby of PE and PTFE microstructure. The results can be explained by the viewpoint that the n-doses induce degradation, cross-linking and crystallinity in PE and PTFE chains.

It has thus been shown that PAL can be an important microprobe to study the microstructure of the polymer in an atomic scale with an accuracy of about 4 picometer.

Keywords : Positron annihilation PE and PTFE, polymers, n-irradiation.

PACS Nos. : 78.70.Bj, 61.82.Pv

Phenomenological anharmonic vibrational models description for the ground state band energies of even-even nuclei

N A Mansour^{1*} and A M Diab²

¹Department of Physics, Faculty of Science, Zagazig University, Zagazig, Egypt

²Radiation control Division, NCNS PR, AEA, Cairo, Egypt

E-mail : nassif_mansour@hotmail.com

Received 27 September 2001, accepted 25 February 2003

Abstract : The results from the cubic polynomial (CP) formula of the square of the angular velocity and the nuclear moments of inertia are compared with those from the variable moment of inertia (VMI) model and the available experimental information on transition energies for yrast line in even-even nuclei. The evaluated model parameters lead to an excellent fit for all energy levels ($I \sim 24$). The calculated critical spin for back bending in the $\pi - I^2$ plot is found to be in agreement with the experimental data.

Keywords : Nuclear structure, rare earth nuclei, moment of inertia, backbending.

PACS Nos. : 21.10.-k, 21.60.-n

Calculation of neutron cross sections for ^{90}Zr , ^{208}Pb and ^{209}Bi in the energy range of 0.5–25 MeV by using the optical model potentials

M M H Miah^{1*}, M N Islam and M R I Faruque²

¹Department of Physics, University of Chittagong, Chittagong-4331, Bangladesh

²Department of Physics, Bangladesh Institute of Technology, Chittagong, Bangladesh

E-mail : moazzem85@yahoo.com

Received 7 August 2002, accepted 25 April 2003

Abstract : Neutron total cross sections and differential elastic scattering cross sections for the nuclides ^{90}Zr , ^{208}Pb and ^{209}Bi were calculated using different global spherical optical potential (SOP) parameter sets at neutron energies from 0.5–25 MeV. Calculated cross sections for the corresponding nuclides were compared with their experimental data obtained by the EXFOR file to select the best fit parameter sets. It is found that the parameter sets of Ferer Rapaport for ^{90}Zr and Bechetti and Greenless for ^{208}Pb , and ^{209}Bi are the best fitted set to obtain the experimental data of total cross sections and angular distributions of these nuclides.

Keywords : Optical potentials, parameter sets, angular distributions.

PACS Nos. : 24.10.Ht, 23.20.En

Optically controlled noise and small-signal behaviour of READ avalanche diode

G N Dash¹, J K Mishra*, I P Mishra and S R Pattanaik

P G Department of Physics, Sambalpur University, Jyoti Vihar, Sambalpur-768 019, Orissa, India

*P G Department of Physics, G M College (Autonomous), Sambalpur-768 004, Orissa, India

E-mail : gndash@rediffmail.com

Received 10 August 2001, accepted 25 February 2003

Abstract : A new analytical model to study the effect of optical radiation on the noise behaviour of a Read type IMPATT diode is presented. The application of this method to a Si-Read diode reveals some interesting features of reduction in the resonance like noise peak due to optical injection.

Keywords : IMPATT, optical, radiation, noise.

PACS Nos. : 85/ kk,73.40, -c

Photoemission studies of metals by using Mathieu potential

B Zoliana¹, Zaithanzauva Pachuau¹, Lalthakimi Zadeng, P K Patra², D T Khathing³ and R K Thapa*

Condensed Matter Theory Research Group, Department of Physics, Pachhunga University College, Mizoram University,
Aizawl, Mizoram-796 001, India

¹Department of Physics, Govt. Zirtiri Residential Science College, Aizawl, Mizoram-796 001, India

²Science Education Centre, North-Eastern Hill University, Shillong-793 003, Meghalay, India

³Department of Physics, North-Eastern Hill University, Shillong-793 022, Meghalay, India

E-mail : rktt@sancharnet.in

Received 25 February 2003, accepted 7 March 2003

Abstract : Photocurrent results from ferromagnetic materials Fe and Ni and *d*-band metals Pd and Cr is discussed which is calculated by using the Mathieu potential for the crystal. A local dielectric functions have been used to calculate the electromagnetic field for the bulk, surface and vacuum regions of the metals.

Keywords : Photoemission, metals, Mathieu potential.

PACS Nos. : 79.60.Bm, 77.22.Ch

Second harmonic generation efficiency in KDP crystals containing alkali halides

R Ananda Kumari and R Chandramani*

Department of Physics, Bangalore University, Bangalore-560 056, India.

Email: smshashidhara@yahoo.com

Received 8 July 2002, accepted 4 April 2003

Abstract : Pure KDP and KDP crystals containing alkali halides with and without Au^+ ions were grown from aqueous solution by slow evaporation. Second harmonic generation (SHG) efficiency measurements were carried out by Kurtz method. The present study justifies that the KDP crystals containing alkali halides have appreciable increase in SHG efficiency compared to pure KDP crystals.

Keywords : Nonlinear optics, KDP crystals, second harmonic generation efficiency

PACS Nos : 42.65 Ky, 81.10.Dn, 61.72.Ss
