

Indian Journal of Pure & Applied Physics

<http://www.niscair.res.in>

Volume 42

Number 2

February 2004

Coden : IJOPAU 42(2) 75-152

ISSN : 0019-5596

CONTENTS

Atomic and Molecular Physics

- Infrared spectra of charge transfer complexes of metal-free phthalocyanine 79
Mukesh Patel, Rajiv Vaidya, Mehul Dave, S G Patel* & A T Oza

Electromagnetism, Optics, Acoustics, Heat Transfer, Classical Mechanics and Fluid Dynamics

- Black YAG crystal and BDN dye as passive Q-switched laser modulators 89
S Sanghi*, N Dodain, Meenakshi & A Agarwal
- Three-input one-output voltage-mode universal filter using FTFN and OTA 93
N A Shah* & M A Malik
- Study on acoustic nature of succinimide in water + DMSO/DMF and dioxan at 303 K 96
J Ishwara Bhat* & Shree Varaprasad N S

Physics of Gases, Plasmas and Electric Discharges

- Effect of general distribution function on electrostatic ion cyclotron instability 104
Ruchi Mishra & M S Tiwari*

Condensed Matter : Structural, Mechanical and Thermal Properties

- Structural phase transition and elastic properties of neptunium compounds at high pressure 112
Prafulla K Jha, M Aynyas & Sankar P Sanyal*
- Structural properties of Fe³⁺ substituted yttrium iron garnet 117
R P Vara, H J Shah, M P Pandya, M C Chhantbar & K B Modi*
- Microhardness of nanocrystalline aluminium phosphate 121
Jose Mathew, Siby Kurien, Marykutty Thomas & K C George*
- Phase transition in Pb based tellurite ceramics 125
Radheshyam Rai*, M P Singh* & N K Singh*

Condensed Matter : Electronic, Structure, Electrical, Magnetic and Optical Properties

- Thermostimulated luminescence (tsl) – thermal treatment in blue coloured calcite crystals 130
V Ponnusamy, V Ramasamy* & J Hemalatha
- Excitation and emission spectra of anti-Stokes luminescence of Tm³⁺ in glass ceramics doped 136
with various concentrations of sensitizer
R Kathuria, B P Chandra, M Ramrakhiani* & D P Bisen
- Study of solvent effect on microwave dielectric relaxation and molecular dynamics in PVP-PEG mixtures 142
R J Sengwa* & Abhilasha

* The corresponding author has been indicated by (*) marks in case of papers with more than one author.

Infrared spectra of charge transfer complexes of metal-free phthalocyanine

Mukesh Patel, Rajiv Vaidya, Mehul Dave, S G Patel & A T Oza

Department of Physics, Sardar Patel University, Vallbh Vidyanagar 388 120

Received 17 September 2003, accepted 13 November 2003

A spectroscopic study of the charge transfer complexes of Metal-free phthalocyanine (H_2PC) in the infrared range has been carried out. Six complexes namely H_2PC -Chloranil, H_2PC -DDQ, H_2PC -TCNQ, H_2PC -TCNE, H_2PC - I_2 and H_2PC -TNF have been prepared and studied. H_2PC acts as an organic donor because of two NH groups in the center and four phenyl rings on the outer core of the molecule. H_2PC is a *P*-conjugated ligand. Forbidden direct transition is found in all the charge transfer complexes.

Black YAG crystal and BDN dye as passive Q-switched laser modulators

S Sanghi*, N Dodain, Meenakshi & A Agarwal

Department of Applied Physics, G.J.University, Hisar 125 001

Received 2 January 2002, revised 26 August 2003, accepted 2 December 2003

Passive Q-switching has been done in Nd:YAG laser transmitter using Black YAG crystal and BDN dye as saturable absorbers. The results have been obtained for two different cases (i) at free running laser threshold and (ii) Q-switched laser action for these absorbers. It has been found that the output peak power in Q-switched laser operation mode is much large for both the absorbers than in free running regime. Further, the results of Q-switched output power obtained with these absorbers have been compared and it has been found that pulse width in case of Black YAG crystal is larger in comparison to that obtained with BDN dye, thereby providing a better way of overcoming spiking phenomenon generally occurring in solid state lasers.

Three-input one-output voltage-mode universal filter using FTFN and OTA

N A Shah & M A Malik

Postgraduate Department of Electronics & Instrumentation Technology
The University of Kashmir, Srinagar 190 006

Received 23 July 2003, revised 17 December 2003, accepted 26 December 2003

A three-input one-output voltage-mode universal biquad capable of realizing lowpass (LP), highpass (HP), bandpass (BP), allpass (AP) and Notch filtering signals from the same configuration without any component matching conditions or cancellation constraints is presented. The proposed topology is based on and employing a single four terminal floating nullor (FTFN), a single operational transconductance amplifier (OTA), and three passive components. The circuit facilitates the tuning of cut-off frequency ω_0 and bandwidth ω_0/Q in an orthogonal manner. The circuit has low sensitivity figures and is canonical as it employs a minimum number of passive components. To verify the theoretical calculations experimental and simulated results are included.

Study on acoustic nature of succinimide in water + DMSO/DMF and dioxan at 303 K

J Ishwara Bhat & Shree Varaprasad N S

Department of Chemistry, Mangalore University, Mangalagangothri 574 199
e-mail: bhatij@yahoo.com

Received 24 June 2003, revised 28 October 2003, accepted 22 December 2003-12-22

The ultrasonic velocity and density at different concentrations of succinimide in water, DMSO, DMF, dioxan and different compositions (V/V) of H₂O + DMSO/DMF/dioxan have been studied at 303 K. The data obtained were used to evaluate adiabatic compressibility, apparent molar adiabatic compressibility, intermolecular free length, specific acoustic impedance, relative association and solvation number. These results were used to calculate the constant B of Jones-Dole's equation and limiting molar compressibility ϕ_k^0 . Gucker's and Jones-Dole's relations were verified. Formation of complex at 50% DMSO, DMF and 20% dioxan were identified. Further these data were utilized in the establishment of solute-solvent interactions under prevailing conditions qualitatively.

Effect of general distribution function on electrostatic ion cyclotron instability

Ruchi Mishra & M S Tiwari

Department of Physics & Electronics, Dr H S Gour Vishwavidyalaya, Sagar (MP) India

Received 7 May 2003 : revised 22 September 2003: accepted 9 December 2003

The dispersion relation, growth rate and marginal stability of the electrostatic ion cyclotron wave with general loss-cone distribution function in low β -homogeneous plasma have been investigated by studying the trajectories of the particles. The effect of the steepness of the loss-cone distribution has been studied for different plasma parameters. The wave is assumed to propagate obliquely to the static magnetic field. The whole plasma is considered to consist of resonant and non-resonant particles. It is assumed that resonant particles participate in energy exchange with the wave whereas non-resonant particles support the oscillatory motion of the wave. It is found that the effect of steepness is to enhance the growth rate. The results are interpreted for the space plasma parameters appropriate to the auroral acceleration region of the earth's magnetoplasma.

Structural phase transition and elastic properties of neptunium compounds at high pressure

Prafulla K Jha¹, M Aynyas² & Sankar P Sanyal^{2*}

¹Department of Physics, Faculty of Science, The M. S. University of Baroda, Vadodara 390 002,

²Department of Physics, Condensed Matter Physics Laboratory, University of Bhopal, Bhopal 462 026

Received 24 October 2003, revised 9 August 2003, accepted 2 December 2003

The high pressure behaviour and pressure induced structural phase transition of three neptunium compounds have been investigated by using a two body interionic potential approach. The calculated compression curves and the values of different high pressure properties for NpSe, NpTe and NpAs are presented and compared with the experimental values wherever available. The calculated values of elastic properties show predominantly ionic nature of these compounds. For NpSe, NpTe and NpAs, the phase transition pressures for structural transition from NaCl to CsCl phase have been predicted at 23.4, 12.9 and 28.2 GPa, respectively.

Structural properties of Fe³⁺ substituted yttrium iron garnet

R P Vara, H J Shah, M P Pandya, M C Chhantbar & K B Modi

Department of Physics, Saurashtra University, Rajkot 360 005

Received 7 May 2003; revised 22 August 2003; accepted 22 September 2003

The compositional dependence of structural parameters like cation distribution, lattice constant, X-ray density, bulk density, porosity, shrinkages and particle size have been studied for $Y_{3-x}Fe_{5+x}O_{12}$ ($x = 0.00, 0.05, 0.15$ and 0.30) garnet system. It is found that substituted Fe³⁺ ions occupy dodecahedral sites while Fe²⁺ ion concentration, determined through EDAX, occupy octahedral (a-) sites in the crystal structure. The values of lattice constant obtained from experimentally estimated cation distribution are not in agreement with measured values; suggest that practically Fe³⁺ ion substitution does not affect the lattice constant. All the parameters studied are interlinked having effect on transport properties.

Microhardness of nanocrystalline aluminium phosphate

Jose Mathew, Siby Kurien, Marykutty Thomas⁺ & K C George

Department of Physics, St. Berchmans' College, Changanassery, Kerala – 686 101

⁺Department of Physics, BCM College, Kottayam, Kerala – 686 001

E-mail: ktm_kcgeorge @ sancharnet . in

Received 17 April 2003, revised received 7 October 2003, accepted 25 November 2003

Nanocrystalline aluminium phosphate with different grain sizes was prepared by a simple and efficient method. Thermolysis of the precursor mass at external temperatures of around 900°C resulted the required phase. The structural evolutions of the samples as a function of sintering temperature and time were monitored by XRD. The FTIR spectra of the samples were taken and the group bonds and their corresponding shifts were analysed. The microhardness of the samples compacted under different pressure ranges were studied. The variations of microhardness with change in grain size, compacting pressure, and density were studied. The microhardness of the sample did increase with increase of compacting pressure and density. Examination of the results also reveals that the microhardness is increased with reduction of grain size in accordance with the normal Hall-Petch relationship.

Phase transition in Pb based tellurite ceramics

Radheshyam Rai¹, M P Singh² & N K Singh³

¹Department of Physics, A N College, Patna 800 013

²Department of Physics, S B College, Ara

³University Department of Physics, V K S University, Ara 802 301

Received 19 August 2003, revised 8 December 2003, 20 December 2003

Polycrystalline samples of ATeO_3 (where $A = \text{Pb}$) were prepared by conventional solid-state reaction technique at 1023K. Preliminary X-ray studies show the formation of the single-phase PbTeO_3 compound with cell parameters $a = 8.795$ (1) Å, $b = 10.312$ (1) Å and $c = 12.11$ Å is an orthorhombic crystal system. Detailed studies of dielectric constant (ϵ) and loss tangent ($\tan\delta$) as a function of frequency (50Hz-100kHz) at room temperature (295 K) and temperature (260-700K) at 10kHz show that compound undergoes a single ferroelectric phase transition of very sharp type at 608K. Both the ac and dc conductivity's have been studied over a wide range of temperature. Measurement of dc resistivity of the material as a function of temperature suggest that compound have negative temperature coefficient of resistance (NTCR) or semiconductor type properties.

Thermally stimulated luminescence (tsl) – thermal treatment in blue coloured calcite crystals

V Ponnusamy, V Ramasamy & J Hemalatha

Department of Physics, Annamalai University, Annamalainagar 608 002.

E-Mail: srsaranram@rediffmail.com

Received 28 October 2003, accepted 14 November 2003

The thermally stimulated luminescence (TSL) glow curve characteristics of ten blue coloured calcite crystals of Southern Tamil Nadu are analysed. The natural thermoluminescence (NTL) measurements were carried out for all the samples and annealed in air at the temperatures ranging from 200 to 700°C, at an interval of 50°C, for 1hr duration. The glow curves of annealed and unannealed samples irradiated with a gamma dose of 500 Gy show three peaks at 145, 255 and 345°C, respectively, when recorded with a linear heating rate of 10°C/sec. Annealing treatment above 400°C increases the sensitivity of all TSL peaks except 345°C. On the other hand, annealing at 700°C caused a collapse in the TSL sensitivity. The enhancement in TSL sensitivity was found to depend on the annealing temperature and time. Annealing treatment at 600°C for 5 hr followed by quenching in air is the optimum conditions for TSL sensitisation and removal of RTL signal. The emission wavelength at 610 nm evidenced that the Mn^{2+} impurity is present in the samples which is responsible for luminescent emission.

Excitation and emission spectra of anti-Stokes luminescence of Tm^{3+} in glass ceramics doped with various concentrations of sensitizer

R Kathuria¹, B P Chandra², M Ramrakhiani³ & D P Bisen³

¹Department of Physics, D. N. Jain College, Gole Bazar, Jabalpur 482 001

²Pt. Ravishankar Shukla University, Raipur 492 010

³Department of Postgraduate Studies & Research in Physics & Electronics
Rani Durgavati University, Jabalpur 482 001

Received 9 August 2003, accepted 17 November 2003

In certain rare-earth doped glass ceramics luminescence emission has been observed at wavelength shorter than the exciting wavelength. This is known as anti-Stokes luminescence or up-conversion, which is due to accumulation of excitation energy by rare-earth ions. In Tm^{3+} and Yb^{3+} doped glass ceramics, Tm^{3+} acts as an activator and Yb^{3+} acts as a sensitizer. The activator concentration was kept constant at 0.2 mol% and the sensitizer Yb^{3+} concentration was varied from 0.0 mol% to 20 mol%. In emission spectra of glass ceramics doped with Tm^{3+} and Yb^{3+} , under infrared excitation (966 nm) one peak of high intensity was found at different wavelengths between 400 to 500 nm for different concentrations of sensitizer. The peak is slightly shifted towards shorter wavelength with increasing concentrations of the sensitizer. This reveals that 3-photon up-conversion is prominent and presence of Yb^{3+} ions slightly shifts the energy levels of Tm^{3+} . In the excitation spectra of glass ceramics doped with Yb^{3+} and Tm^{3+} , initially the emission intensity increases with increasing wavelength, attains an optimum value for 920 nm, 930 nm, 950 nm and 960 nm and then it decreases with further increase in the wavelength. These photon energies may correspond to energy difference between levels of Tm^{3+} or Yb^{3+} . Both in the excitation spectra and emission spectra, initially the anti-Stokes luminescence intensity increases with sensitizer concentration, attains an optimum value and then it decreases with further increase in the sensitizer concentration.

Study of solvent effect on microwave dielectric relaxation and molecular dynamics in PVP-PEG mixtures

R J Sengwa & Abhilasha

Microwave Research Laboratory, Department of Physics
JNV University, Jodhpur 342 005

Received 17 July 2003; revised 17 September 2003; accepted 2 December 2003

The dielectric relaxation of poly(vinyl pyrrolidone) (PVP) ($M_w=40000 \text{ g mol}^{-1}$) and poly(ethylene glycol)s (PEG) ($M_w = 200$ and 400 g mol^{-1}) and their binary mixtures in dilute solutions of dioxane has been studied performed at 10.1 GHz and 35°C. The average relaxation time τ_0 , relaxation time corresponding to segmental motion τ_1 and group rotations τ_2 , distribution parameter α and free energy of activation ΔF^\ddagger of these mixtures has been determined. These results have been compared with the values of relaxation times obtained earlier in benzene solutions to explore the affect of solvent environment on molecular dynamics. The values of α for PVP-PEG200 and PVP-PEG400 were found in the range of $\approx 0.18 - 0.75$. The anomalous variation in the values of τ_0 and τ_1 of these binary systems has been studied by considering the stretching effect in PEG molecular chain length in dilute solutions and the number of hydrogen bonding between carbonyl groups of PVP monomer units and terminal hydroxyl groups of PEGs in complex heterogeneous network. Further, in both benzene and dioxane solvents the τ_2 values of PVP-PEGs mixtures are found to be nearly equal. This shows that group rotation is independent of the nature of solvation medium and attributed to the rotation of PEG chain ends -OH groups about the C-O bond in dynamic equilibrium. The relaxation times of PVP-PEGs in dilute solutions are found to be independent of the mixtures and solvent viscosity. The variations in dipole moment μ values of PEGs molecules in different solvents were explored by incorporating the solute-solvent interactions in hydrogen-bonding non-polar solvents.