DF 15: Optical and nonlinear optical properties, photonics II

Time: Thursday 10:00–12:50 Location: H11

Invited Talk DF 15.1 Thu 10:00 H11

Photons meet sound waves — •Jan K Krüger and Roland Sanctuary — University of Luxembourg, Laboratoire de physique des matériaux, Luxembourg, Luxembourg

High performance Brillouin spectroscopy is an optical method which is predominantly used for studies of the mechanical behaviour of condensed matter at hypersonic frequencies. Brillouin spectroscopy works contact- and destruction-less but needs rather transparent samples. The latter prerequisite is for soft matter no real restriction, especially, because the samples can be made thin. The typical probe volume is 10-8 cm3. After a short introduction to the theoretical background a description of the experimental technique will be given including an introduction to modern acoustic microscopy. The wide spectrum of useful applications of Brillouin spectroscopy will be demonstrated using examples from synthetic and biological polymers.

5 min. break

DF 15.2 Thu 10:45 H11

Optical properties of Calcium Barium Niobate — •Urs Heine[1], Klaus Betzler[1], Manfred Burianek[2], and Manfred Muehlberg[2] — [1]Department of Physics, University of Osnabrueck, D-49069 Osnabrueck — [2]Institute of Crystallography, University of Cologne, D-50674 Cologne

We report on optical measurements on the novel tungsten bronze type Calcium Barium Niobate. [001]-oriented transparent and colorless single crystals were grown by the Czochralski method with dimensions of 12 mm in diameter and about 80 mm in length. With its relatively high Curie temperature of about 538 K for the congruently melting composition of 28.1 mole% calcium and its high nonlinear coefficients, CBN is a promising material for future applications. Recent experiments revealed, that the application of an external electric field of several kV/cm to CBN at room temperature leads to an increasing opacity of the sample. This might be a drawback considering the future usability of CBN in optical systems. We present investigations on the transmittance behaviour of CBN under external electric fields, demonstrating the erasement of the clouding without affecting the polarization. Experiments have been performed at temperatures ranging from room temperature to approximately 480 K. When heating up the sample, its colorless appearance changes to a light yellow, which can be attributed to a shift of the band edge to longer wavelengths with increasing temperature. To further investigate the transmittance properties of CBN, measurements of the band edge under various temperatures up to the ferroelectric phase transition have been performed.

DF 15.3 Thu 11:05 H11

Investigation of nonlinear optical effects in strontium barium niobate — •Alexander Niemer, Rainer Pankrath, and Klaus Betzler — University of Osnabrück, Department of Physics, Barbarastr. 7, 49076 Osnabrück

The ferroelectric relaxor and optical nonlinear material strontium barium niobate (SBN) shows some very interesting effects in the nonlinear generation of light and offers the possibility to study the interaction between the luminescence of rare earth ions and the nonlinear processes.

The possibility of getting radially polarized light from an SBN crystal is investigated. By excitation with an optical parametrical oscillator radially polarized white light can be generated. In the literature [1] it is shown, that such light can be focused to a smaller spot size than linear or azimutal polarized light. At the moment an about 10% smaller spot size is realized.

Further the luminescence from different rare earth impurities is studied. To understand the processes which are responsible for the upconversion the dependency of time and excitation energy was investigated. For erbium and ytterbium an anomalous dependency of the fluorescence decay time on the dopant concentration is found. Because ytterbium doped SBN shows a very high luminescence intensity the luminescence light could be used for other nonlinear processes like, e.g. sum frequency generation.

[1] R. Dorn, S. Quabis, G. Leuchs: Optics Communications 179, 1-7 (2000)

DF 15.4 Thu 11:25 H11

Temperaturabhängigkeit des Optischen Schadens in Lithiumniobat-Kristallen* — •Niklas Waasem[1], Fabian Lüdtke[1], Mercedes Carrascosa[2] und Karsten Buse[1] — [1]Physikalisches Institut, Universität Bonn, Wegelerstr. 8, 53115 Bonn, Deutschland — [2]Departamento de Física de Materiales C-IV, Universidad Autónoma de Madrid, Campus Cantoblanco, E-28049, Madrid, España

Lithiumniobat-Kristalle besitzen große nichtlineare optische Koeffizienten, die Frequenzkonversion von Laserlicht ermöglichen. Oft behindert der photorefraktive Effekt den Einsatz der Kristalle jedoch erheblich: Unkontrollierte lichtinduzierte Brechungsindexänderungen zerstören die Phasenanpassung und führen zu einer Verzerrung des Strahlprofils. Dieses unerwünschte Auftreten des photorefraktiven Effekts wird „Optischer Schaden“ genannt. Seit seiner Entdeckung vor 50 Jahren ist der Effekt nicht vollständig unter Kontrolle gebracht worden.

Das Ziel unserer Untersuchungen ist ein tieferes Verständnis des Optischen Schadens zu erlangen. Hierzu wird die Schwellintensität für das Einsetzen des Optischen Schadens in Abhängigkeit von der Kristalltemperatur anhand der Verzerrung eines durch den Kristall transmittierten Laserstrahls gemessen. Wir finden ein Arrhenius-Verhalten mit der Aktivierungsenergie 0.5 eV. Ein kürzlich entwickeltes Modell zur Erklärung des Optischen Schadens von Carrascosa et al., welches auf zwei photorefraktiven Zentren basiert, kann die Ergebnisse gut erklären. *Unterstützt von der Deutschen Forschungsgemeinschaft, der Deutschen Telekom AG und dem DAAD.

5 min. break

DF 15.5 Thu 11:50 H11

Ionendurchstrahltes Lithiumniobat: Änderung optischer und elektrischer Materialeigenschaften* — •Niels Lennart Raeth, Lena Jentjens, Konrad Peithmann und Karl Maier — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

Lithiumniobat findet vielfache Anwendungen in Wissenschaft und Technik, insbesondere in optischen Bereichen. Um die Vorzüge des Materials vollständig ausnutzen zu können, ist eine genaue Kenntnis und die Möglichkeit zur Modifikation der Materialparameter erstrebenswert.

Wird Lithiumniobat mit schnellen ^{3}He-Ionen bei einer Energie von 41 MeV durchstrahlt, können entscheidende Materialeigenschaften gezielt großvolumig und strukturiert geändert werden. In der durchstrahlten Region werden langzeitstabile Brechungsindexänderungen, sowie eine Herabsetzung der Koerzitivfeldstärke beobachtet. Darüber hinaus zeichnet sich nach der Bestrahlung eine erhöhte Leitfähigkeit des Materials sowie eine erhöhte Dichte an Nukleationskeimen ab.

*Gefördert durch die Deutsche Forschungsgesellschaft (FOR557,R2)

DF 15.6 Thu 12:10 H11

Transient light–induced absorption in thermally reduced, periodically poled lithium niobate doped with yttrium — •Bettina Schoke[1], Mirco Imlau[1], Christoph Merschjann[2], Garbor Corradi[3], Katalin Polgar[3], and Inna Naumova[4] — [1]Physics Department, University of Osnabrück, Germany — [2]Helmholtz-Zentrum Berlin GmbH, Germany — [3]Research Institute for Solid State Physics and Optics, Hungarian Academy of Sciences Budapest, Hungary — [4]Physics Department, Moscow State University, Russia

Excitation and recombination processes of small polarons are studied in thermally reduced, periodically poled $LiNbO_3$ doped with Y (PPLN:Y). The reduction treatment creates bipolarons (Nb_{Li}^{4+}:Nb_{Nb}^{4+}) which are stable at room temperature. They may be dissociated optically into small bound (Nb_{Li}^{4+}) and free (Nb_{Nb}^{4+}) polarons ("optical gating"). The light-induced absorption arising from the population and depopulation of these centers is measured time–resolved via transient absorption spectroscopy in the blue and red spectral range after optical excitation with intense laser pulses ($\lambda = 532\,\mathrm{nm}$, $t = 8\,\mathrm{ns}$). Besides dissociation and relaxation of bipolarons the investigations also indicate the presence of photo-induced hole polarons (O^-) with comparatively longer lifetime. The findings can be explained by a periodic spatial modulation of the Nb_{Li}^{5+} antisite concentration and of the degree of reduction. Both modulations most likely result from a periodic incorporation of Y ions on Li sites. *Financial support by the DFG (IM 37/5-1, GRK695) is gratefully acknowledged.

DF 15.7 Thu 12:30 H11

Tunability of photoswitchable ruthenium sulfoxide compounds on the basis of ligand substitution — •Sebastian Eicke, Volker Dieckmann, Kristin Springfeld, and Mirco Imlau — Deparment of Physics, University of Osnabrück, Barbarastr. 7, D-49069 Osnabrück, Germany

Photoswitchable ruthenium sulfoxide compounds provide a light-induced linkage isomerization in combination with pronounced changes in characteristic optical properties.

As representative of the ruthenium sulfoxide group the molecular compound $[Ru(bpy)_2(R\text{-}OSO)]^+$ (OSO: 2-methylsulfinylbenzoate) can be tuned in its optical properties by the substitution of the photoswitchable ligands (R=Bn, BnCl, BnMe). These modified sulfoxides were studied in respect to their photochromic properties and kinetics of the generation and relaxation of the light-induced isomers. The kinetics were determined by pump-probe technique and show in each case two reversible termal decay processes following Arrhenius law. The two photo-excited states offer lifetimes in the magnitude of $\tau_1 \approx 10^3$ s and $\tau_2 \approx 10^4$ s at room temperature with activation energies about $E_{A,I} = 0.72$ eV to 0.92 eV and $E_{A,II} = 0.8$ eV to 1.00 eV. Another respresentative of the photoswitchable sulfoxides is the $[Ru(bpy)_2(pySO)]^{2+}$ compound. This molecule is the first sulfoxide which allows for reversible switching between the ground and metastable states by light exposure. With this compound the sulfoxides are highly qualified for optical data storage on a molcular scale.

Financial support by the DFG (GRK 695).