DF 9 Phase Transitions

Time: Thursday 09:30–12:30 Room: MÜL Elch

Invited Talk

DF 9.1 Thu 09:30 MÜL Elch

Driving a macroscopic state switching into materials with a laser pulse and probing atoms moving in real time with a X-ray pulse — •CAILLEAU Herve[1,2], COLLET Eric[1,2], BURON Marylise[1,2], LEMEE-CAILLEAU Marie-Helene[3], and KOSHIHARA Shin-ya[2,4] — [1]Groupe Matiere Condensee et Materiaux, Cnrs-Université Rennes 1, F 35042 Rennes Cedex, France — [2]ERATO, JST, Japan — [3]Institut Lauë-Langevin, Grenoble, France — [4]Tokyo Institute of Technology, Tokyo, Japan

The possibility of controlling with a single ultra-short laser pulse the coherent and cooperative transformation of the state of atoms or molecules in solid state opens new avenues in materials science. This challenge of driving a macroscopic state switching on an ultra-fast time scale, so realizing at the material level what has been done at the molecular level in femto-chemistry, goes beyond the current principles. Indeed, these new out-of-equilibrium processes are highly cooperative and highly non-linear. In other words, light can induce self-amplification and self-organization processes in the material, a so-called photoinduced phase transition. Molecular materials are particularly promising by virtue of light tuning of the charge state and/or spin state in molecules. Another new step is the recent possibly to directly observe in real time the assembly of molecules in a solid moving in a regimented way towards the new electronic and structural order by using the emerging ultra-fast X-ray diffraction. Reference: * Photoinduced Phase Transitions*, K. Nasu ed., World Scientific (2004).

Invited Talk

DF 9.2 Thu 10:10 MÜL Elch

Structural instabilities in Ferroelectric Aurivillius compounds — •J. Manuel PEREZ-MATO — Dept. Fisica Mat. Condensada, Fac. Ciencia y Tecnologia, Univ. del Pais Vasco, UPV/EHU, Apdo 644, 48080 Bilbao, Spain

The Aurivillius phases are layered bismuth oxides formed by the regular stacking of Bi2O2 slabs and perovskite-like blocks. Many are ferroelectric at room temperature and are of special technological interest. Apart from the polar distortive mode, other displacive modes at the Brillouin zone border are unstable and are frozen in the room temperature structure. The close interplay of these different instabilities situates these systems beyond the conventional framework for perovskite ferroelectrics. We present ab-initio calculations and thorough structural and symmetry analyses of two specific compounds, SrBi2Ta2O9 (SBT) [1], and Bi4Ti3O12 (BTO), which have respectively two and three layers of BO3 octhaedra within the perovskite blocks. The energy landscape around the parent tetragonal configuration has been explored analysing the possible existence of intermediate phases. The essential role of secondary hard modes for the stabilization of the ferroelectric phase is shown. Surprisingly, the rigid-like behaviour of the perovskite octahedra in BTO is the result of anharmonic couplings. Energy maps have been compared with empirical bond valence criteria with a striking agreement of both approaches [2].

[1]Perez-Mato et al., Phys. Rev. B (2004) 70, 214111
[2]Etxebarria et al., Phys. Rev. B (2005) 72, 174108

DF 9.3 Thu 10:50 MÜL Elch

Soliton Density in Incommensurate Thiourea — •Robert Blinc[1] and Tomaž Apih[2] — [1]J. Stefan Institute, Jamova 39, Ljubljana, Slovenia — [2]. Stefan Institute, Jamova 39, Ljubljana, Slovenia

Whereas soliton regimes have been reported in the past in type I incommensurate systems where the order parameter is at least two-dimensional and a Lifshitz invariant drives the system to a modulated incommensurate phase, this is not the case with type II incommensurate systems such as thiourea. Here there is no Lifshitz invariant and the order parameter is one-dimensional. It has been generally assumed until recently that the incommensurate modulation of type II systems is always of the plane wave type. Recent X-ray scattering results seem to show the appearance of soliton like modulation profiles close to the lock-in transition in thiourea. Perez - Mato provided a possible theoretical explanation of this situation. Here we show that the deuteron NMR spectra of thiourea exhibit a gradual change of the incommmensurate modulation wave from the plane wave to the soliton type. We determined the temperature dependence of the soliton density and compare the results with the theory of Perez - Mato. The obtained data support the above mentioned theoretical results and show that type II incommensurate systems can indeed exhibit a multi soliton lattice regime similar to that found in type I incommensurate systrems like RbZnCl4 and others.

DF 9.4 Thu 11:10 MÜL Elch

Poling Effect on the Ferroelectric and Transport Properties of Soft Piezoelectric PZT — •T.M. Kamel, F. X. N. M. Kools, and G. de With — Laboratory of Materials and Interface Chemistry, Eindhoven University of Technology, 5600 MB Eindhoven, the Netherlands

The properties of the piezoelectric ceramic materials are strongly dependent on the degree of polarization as set by the poling process. In the present work a soft piezoceramic PZT material was polarized at different poling conditions. Three different methods were used to evaluate the polarization state in the material. These are the polarization current, pyroelectric coefficient and the hysteresis loop measurements. The polarization current was monitored during the poling process at different applied electric fields, poling time and temperature. The pyroelectric coefficient and hence the polarization was calculated form the pyroelectric current vs. temperature. The hysteresis loop was displayed using a home-made computerized Sawyer-Tower circuit. The dielectric, ferroelectric and piezoelectric properties were measured as a function of temperature and frequency after different poling conditions. The effects of the various poling conditions on the functional and physical properties of the soft PZT are presently discussed.

DF 9.5 Thu 11:30 MÜL Elch

Investigation of the relaxor system Strontium-Barium-Niobate by Second Harmonic Generation — •Uwe Voelker, Klaus Betzler, and Sergey Podlozhenov — Universität Osnabrück, Fachbereich Physik, Barbarastraße 7, D - 49069 Osnabrück, Germany

The relaxor phase transition in ferroelectrics is still not completely understood. In contrast to past investigations, we use second harmonic generation (SHG) as a tool to observe the behavior of the bulk of $Sr_{0.61}Ba_{0.39}Nb_2O_6$(SBN). Thus we are able to watch closely how particular classes of domains lose their spontaneous polarisation while passing through the phase transition without integrating over the whole crystal. We will present the concentration-dependence of the relaxor phase transition of SBN doped with rare earth-metals obtained by these measurements. Supported by DFG (project GRK 695).

DF 9.6 Thu 11:50 MÜL Elch

Non-ergodic behavior of polar state in Li-doped KTaO3 under an electric field — •Yoshiaki Uesu[1], Hiroko Yokota[1], Taeko Oyama[1], Charlotte Malibert[2], and Jean-Michel Kiat[2] — [1]Department of Physics, Waseda University, 3-4-1 Okubo, Shinjuku-ku, Tokyo 169-8555, Japan — [2]SPMS, Ecole Centrale Paris, Grande Voie des Vignes 9225 Chatenay-Malabry, France

Incipient ferroelectric KTaO3 doped with Li-3% was investigated in order to clarify the dipole state under electric field. Using optical second-harmonic generation (SHG) microscope, we observed a marked history dependence of SHG intensity through zero-field cooling (ZFC), zero-field heating (ZFH), field heating after ZFC (FH/ZFC) and FH after field cooling (FH/FC) for both crystals. At fixed temperature in FH/ZFC, the long relaxation process to the equilibrium state is observed dependent on temperature. In quite low temperature, the SHG does not develop under the electric field. This kind of non-ergodicity is known to be a character of inhomogeneous system. Further experiments are performed using precise X-ray diffraction method. It reveals that two-step transformation occurs: at 50K, remarkable field-induced SHG and photo-conductivity accompanied by tetragonal lattice strain occur, while at 90K, does only small lattice strain. The fact indicates that polar nano-regions generated at 90K in nonpolar cubic matrix are transformed into ferroelectric micro-domain state at 50K without field. Under an electric field, the micro-domain state is changed to macroscopic ferroelectric state.

DF 9.7 Thu 12:10 MÜL Elch

Mapping of Microwave-Induced Phonons by Mikro-Brillouin Spectroscopy: High Resolution Access To Acoustic Fields In Piezoelectric Materials — •Mathias Kolle, Jan Kristian Krüger, Brice Vincent, Roland Sanctuary, Laurent Le Brizoual, Omar Elmazria, Laurent Bouvot, Didier Rouxel, and Patrick Alnot — Laboratoire Européen de Recherche Universitaire : Saarland-Lorraine, Universität des Saarlandes, Bau E6.2, D-66041 Saarbrücken

Brillouin spectroscopy (BS) is a versatile technique to measure acoustic properties at hypersonic frequencies and has been proven to be capable to detect thermally excited surface- and guided acoustic waves at microwave frequencies. BS on microwave induced phonons, generated at the surface of piezoelectric crystals can be used to determine the sound velocity of surface acoustic waves as well as their hypersonic attenuation from the decay of the Stokes intensity of the BS. Only recently, BS was used for studying acoustic microscopy (BM). It turns out that this new technique is able to characterize the distribution of acoustic fields, generated by inter digital finger structures (IDTs) at microwave frequencies in piezoelectric materials. The aim of this talk is to elucidate the efficiency of the electro-acoustic generation of hypersonic waves in thin piezoelectric films including their field properties and especially their spatial decay within the film plane.