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HiLASE Centre is pleased to invite you to attend the seminar:

Electronic transport in bi and Bi-Sn diluted alloys

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Semimetals and narrow-gap semiconductors have found numerous applications in modern electronics as they combine high-mobility of charge carriers and low-energy electronic transitions. The recent progresses in development of thermoelectric devices, THz emitters and infrared detectors justify the need for understanding of influence of various factors (like temperature and doping) on electronic states in this class of materials. Current knowledge of temperature, doping and morphology effect on those properties needs further improvement, especially for the Bi-based materials. The modern advantages in numerical analysis open the new prospective for better understanding the experimental data dedicated to morphology and doping effect on charge carrier parameters in wide temperature range for Bi-based compositions.

For this study, electronic properties of $Bi_{100-x}Sn_x$ ($0 \le x \le 0.08$ at.%) polycrystalline films involving magnetoresistance, Hall and Seebeck coefficients were measured under magnetic field up to 8 T in temperature range 4 – 300 K. Structure of samples was investigated by X-ray diffraction, atomic force microscopy, scanning electron microscopy, electron backscatter diffraction, energy-dispersive X-ray spectroscopy. We applied the following computational techniques: a) finite-element analysis for prediction of polycrystalline film properties from its texture b) generalized nonlinear least-squares optimization for quantitative mobility spectrum analysis that allows determination of charge carrier properties in materials with several carrier species c) solution of nonlinear equations system for the simplified evaluation of charge carrier characteristics in pure Bi.

A new method based on solution of charge and heat transport coupled equations is proposed for the computation of Seebeck coefficient of Bi films with grain size higher that mean free path of carriers. It is shown that temperature-independent electronic scattering on grain boundaries dominates in electrochemically deposited films due to grain size comparable to the mean free path of charge carriers in bulk material. After annealing or in the rapidly crystallized foils temperature-dependent phonon scattering predominates. Temperature dependences of concentrations and mobilities as well as Fermi level position were established in the range from 10 to 300 K for $Bi_{100-x}Sn_x$ ($0 \le x \le 0.08$ at.%) by means of developed implementation of quantitative mobility spectrum analysis augmented by additional integral equations. the last also has shown decrease of bands overlap with increase of tin concentration.

The results of work can be used 1) for characterization of electronic structure of materials with several types of charge carriers; 2) for design of materials based on bismuth-tin alloys with controllable energies of electronic transitions; 3) in educational process for delivering modern numerical methods for experimental data analysis in condensed matter physics.

When: Wednesday, 04/09/2019 at 10:30

Where: Seminar room, HiLASE Centre

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