Synthesis and characterization of $NbSe_2$ crystals and nanofilms

Dimitre Z. Dimitrov[1,2]*, Vera Marinova[2], Irnik Dionisiev[2], Valentina Mussi[3], Walter Fuscaldo[3], Dimitrios C. Zografopoulos[3]
*lead presenter: dzdimitrov@issp.bas.bg
[1] Institute of Solid State Physics, Bulgarian Academy of Sciences, 1784, Sofia, Bulgaria
[2] Institute of Optical Materials and Technologies, Bulgarian Academy of Sciences, 1113, Sofia, Bulgaria
[3] Consiglio Nazionale delle Ricerche, Istituto per la Microelettronica e Microsistemi, 00133 Rome, Italy

Very few 2D superconductors exist in nature, and single-layer niobium diselenide ($NbSe_2$) is the first among them that remains a superconductor in its isolated, 2D form without the need of a special substrate [1]. Furthermore, charge density wave (CDW) order - spatial modulation of both the electron density and the atomic lattice - has been revealed to be a genuine 2D electronic phenomenon in $NbSe_2$. 2H-$NbSe_2$ is a metal, a superconductor with Tc ~7.2K and a Charge Density Waves (CDW) system with T_{cdw} of ~33K. The layers are stacked together via van der Waals interactions and can be exfoliated into thin 2D layers. The preparation of high crystalline quality samples of $NbSe_2$ with desired crystal structure is of primary importance for study of their properties.
Single crystals of $NbSe_2$ having a layered structure were grown by chemical vapor transport technique (CVT) using bromine as transporting agent [2]. The energy dispersive analysis (EDS) gives the confirmation about the stoichiometry of the grown single crystal. X-ray diffraction (XRD) and Raman spectroscopy studies were performed for the structural and phase characterization.
$NbSe_2$ thin film samples were prepared by thermally-assisted selenization of magnetron-sputtered Nb film in Ar/H_2 gas mixture flow. The thin films were characterized structurally by XRD as well as by XPS methods to obtain the crystal quality, chemical composition and stoichiometry. Optical and electrical properties are further examined towards device applications.

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References

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