On and Off Rashba Effect in PbSnSe Quantum Wells

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The dependence of Rashba effect in a topological crystalline insulator quantum well (QW) on the atomic composition of the surface is studied. The theoretical tight-binding results are compared with experimental angle resolved photoemission (ARPES) investigations of epitaxial heterostructures consisting of $Pb_{1-x}Sn_xSe$ surface QWs grown by molecular beam epitaxy on $Pb_{1-y}Eu_ySe$ barriers. It is shown experimentally that in situ submonolayer Sn deposition on the QW's surface switches on a strong Rashba effect in the conduction band of the structure. The heterostructure is modeled using a tight-binding approach and recursive Green's function method to derive the surface spectral density of states of the material. In our calculations the observed Rashba effect was simulated by applying a potential described by Thomas-Fermi screening model. Taking into account that Sn covers only partially the surface of the QW and changing accordingly the amount of charge in the system, we show that indeed a Rashba splitting should appear when ca 0.3 monolayer of Sn cation atoms is deposited on the surface of the QW. Subsequently, Te atoms were deposited on the QW's surface. It is shown, both experimentally and theoretically, that such submonolayer deposition of Te anion atoms leads to diminishing and finally complete switching off the Rashba effect.

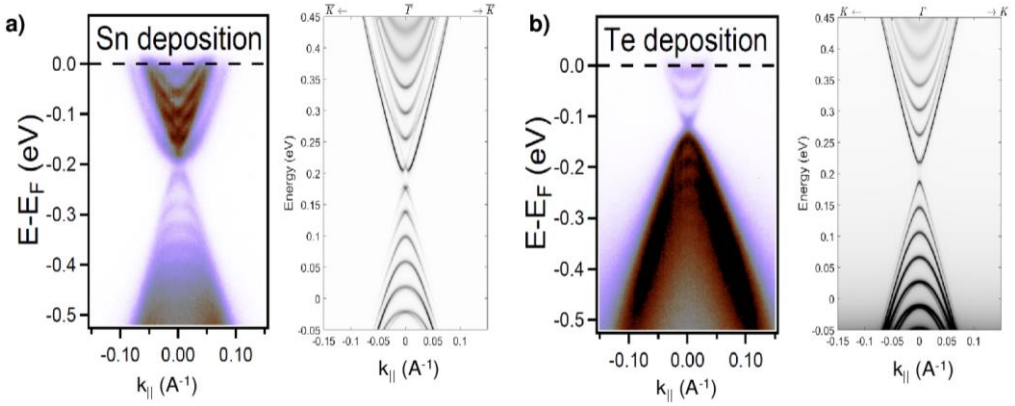

Fig.1 ARPES maps and tight-binding spectral density of states of 20nm thick $Pb_{0.75}Sn_{0.25}Se$ QW on $Pb_{0.9}Eu_{0.1}Se$ barrier after deposition of a) Sn b) Sn and Te submonolayer. ARPES maps were measured with a photon energy of 18 eV around the Γ point of the surface Brillouin zone; tight-binding spectral density of states were calculated for a surface potential $V(z)=V_0e^{-z/\lambda}$ with V_0=-0.21 eV and λ=3.4nm.

This work was supported by the Polish National Science Centre under project 2016/23/B/ST3/03725. The work of V. V. Volobuev in Poland is supported by the Foundation for Polish Science through the IRA Programme co-financed by EU within SG OP.