Scattering of surface state carriers in Bi(111) nanofilms, grown on Si(111) by Pb and Sb adatoms

Sergii Sologub[2], Philip Kröger[1], Daniel Lükermann[1], Herbert Pfnür[1], Christoph Tegenkamp[1]

[1]*Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstr.2, 30167 Hannover, Germany*
[2]*Institute of Physics, National Academy of Sciences of Ukraine,46 Nauki Ave., Kyiv 03028, Ukraine*

The surfaces of semimetallic thin-film systems, such as Bi(111), exhibit strong similarities with topological insulators. They represent a relatively simple, easy to prepare system to study questions related to topological insulators. The quantum size effect makes thin films semiconducting in the bulk at low temperature so that transport properties of epitaxial Bi films are mainly due to surface conductance in the strongly spin-split surface electronic states that cross the Fermi level.

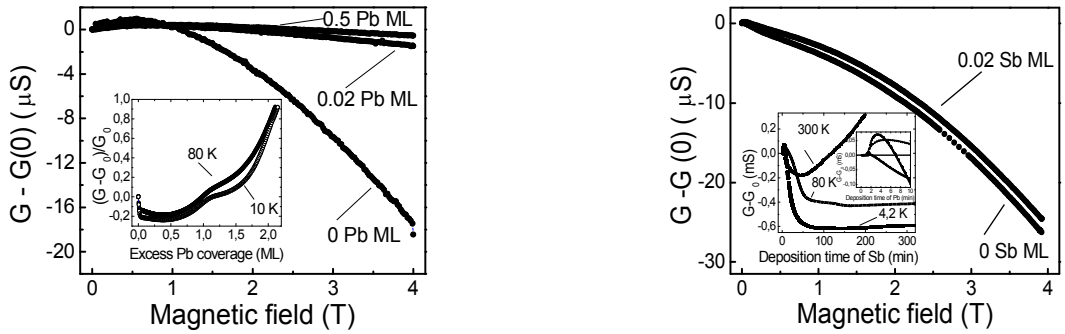

Fig. 1. Change of magneto- and electrical (inserts) conductance of 20BL epitaxial film Bi(111) during adsorption of Pb (left) and Sb (right). G_0 and G(0) is conductance at zero adsorbate coverage and in zero magnetic field.

Our investigation of modifications of surface magneto-conductance by Pb or Sb adsorption on Bi(111)-films, grown epitaxially on Si(111) substrate, complements earlier studies of the effect of impurity scattering by adsorbed atoms with varying magnetic moments and charge transfer between adatoms and surface states [1-4]. Pb adsorption leads to the initial sharp electrical conductance decrease caused by increasing of carrier scattering on adatoms (Fig 1, left). Sb adsorption results in the initial conductance increase (Fig. 1, right) due to charge redistribution between adatoms and surface electronic states, followed by a decrease as a function of Sb concentration, caused by enhanced surface scattering. Comparison of scattering efficiency of different adatoms (Bi, Co, Fe, Tb, Cr, Pb, Sb), as determined by magnetoconductance and Hall resistance measurements demonstrates that Sb adatoms are the weakest scatterers.

1. D. Lükermann, S. Sologub, H. Pfnür, C. Tegenkamp, Phys. Rev. B **83** (2011) 245425.
2. D. Lükermann, S. Sologub, H . Pfnür, C. Klein, M. Horn-von Hoegen, C. Tegenkamp, Phys. Rev. B **89** (2012) 19432.
3. S. Sologub, D. Lükermann, H. Pfnür, C. Tegenkamp, Phys. Rev. B **88** (2013) 115412.
4. P. Kröger, S Sologub, C Tegenkamp, H. Pfnür, J. Phys.: Condens. Matter **26** (2014) 225002.