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Mechanical properties of TbSb thin films

T Minashvili, Z Jabua, A Gigineishvili and **G Iluridze**
Georgian Technical University, Georgia

Rare Earth antimonides continue to receive a great deal attention owing to their interesting properties, but their mechanical properties are hardly studied. In this paper, the technologies of preparation of TbSb thin crystalline films are developed and studied their relative mechanical strength. TbSb were grown by vacuum-thermal evaporation from Tb and Sb separate sources. As substrates we used monocrystalline silicon, glass ceramics and sapphire. Films had an NaCl type cubic structure with lattice parameter $a = 6,16 \pm 0,04$ Å. According to X-ray microanalysis date the composition of the films was 50.1 ± 0.1 at% Tb and 49.9 ± 0.1 at% Sb. According to auger electron analysis data, the films had uniform composition-dept profiles within experimental uncertainty (± 0.3 at%). By full erase method the relative mechanical strength of films was determined. The essence of the method lies in the fact that it is possible to judge the mechanical strength of the film and the extent of its adhesion to the substrate according to the work that must be expended in order to completely erase the film from the substrate surface. The studied film is based on the lower end of a rod on which is fixed working material - a piece of chamois, which is covered with diamond paste. The load of a certain weight is put on rod. By appropriate mechanism rod is moving back and forth. Thus the film strength during constant load is measured by the number of passes required for complete erase film from the substrate. As the technique described for decisive factor is the thickness of the film, all the studied films by us had the same width - 0.7 mm, and the load was also the same and composes 250 g. Studies have shown, that the number of passes over the film to completely erase, increases depending on the composition of the substrate in the following sequence: monocrystalline silicon - glass ceramics - sapphire. For fully erase films deposited on a single monocrystalline silicon substrate requires 48-51 passes, for the films deposited on the substrate pyroceramics - 65-69 passages and films prepared on sapphire substrate - 81-82. This fact may be connected to that the coefficient of thermal expansion of sapphire (8.1, 10^{-6}/K) closer the coefficient of thermal expansion TbSb (12.0, 10^{-6}/K), while the difference of these parameters for monocrystalline silicon (2.5, 10^{-6}/K) is greater than the glass ceramic (4.1, 10^{-6}/K) and is placed in an intermediate position. The greater the difference in thermal expansion coefficients of the substrate and the film, the greater the mechanical stress occurs in the film, which ultimately reduces the mechanical strength. As shown in specially held researches, delay of TbSb films on atmospheric air during 3-4 weeks causes creating additional peeks on TbSb X-rey diffractogram, which do not belong to TbSb. Relative mechanical strength of such films decreases approximately by 30%.

Biography

Tamaz Minashvili obtained PhD in Mathematical Sciences from A F Ioffe Physico-Technical Institute, St. Petersburg in 1987. He is the Associate Professor of Georgian Technical University, Faculty of Informatics and Management Systems, Department of Physics. He has published more than 55 papers in reputed journals. His area of scientific interests: Thin films and their electrophysical, mechanical and optical properties.

tamazminashvili@gmail.com

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