Microhardness Measurements for MBE-Grown, Metal Telluride Layers: 'Pop-In' Effect and Dislocations

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An application of a modern technique (like, e.g., MBE method) to the semiconductor crystal growth enables obtaining a thin slab of a given material with almost perfectly flat (within an atomic scale) layer surface. This property of thin layers and two-dimensional structures not only gives an access to the detailed surface morphology studies (including, e.g., new types of a surface atoms arrangement), but also opens an opportunity to investigate selected mechanical properties of a given material with often much better precision, than that available while studying the bulk crystals obtained by the 'classical' growth techniques.

The results of microhardness measurements performed on carefully prepared, high-quality, bulk semiconductor wafers serving as substrates for MBE growth demonstrated, that it is possible to get new, valuable information on mechanical properties of investigated materials by a nanoindentation. In particular, it was possible to investigate in detail parameters describing the elastic (reversible) deformation, the nucleation, generation and motion of dislocations, the process of plastic (irreversible) deformation etc. A clear feature on a load–depth curve illustrating an indentation into a semiconductor – the sudden jump in displacement at a given load – was often observed. The initial yielding was related to the onset of plasticity since the deformation behavior for smaller loads was elastic. The 'pop-in' effect mentioned above was recently observed not only in Si and in selected III-V compounds, but also in ZnTe, CdTe or ZnO.

The aim of the present work was to look for similar effects in slightly less known semiconducting compounds, which are nevertheless very important for selected applications: MnTe and PbTe. Several few μm thick ZnTe, CdTe, and MnTe layers with the *fcc* crystal structure of the zinc blende type grown on GaAs substrates by MBE and characterized by SEM, AFM, and XRD were investigated by the nanoindentation method. The few μm thick, MBE-grown PbTe layer with the *fcc* crystal structure of the NaCl type was examined by the same experimental methods. In all four cases the 'pop-in' effect was observed and analyzed. The values of parameters describing selected mechanical properties of investigated compounds were compared with those available from the literature, corresponding to other materials, and discussed.

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