Low temperaure processing of nanostructures based on II-VI semiconductors quantum wells

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Modulation doped quantum wells made of II-VI materials posses a unique properties as compared to theirs III-V counterparts. For example CdMgTe/CdMnTe structures are important in the constructions of the novel spintronic devices [1], whereas HgTe/CdTe heterostructures dominate the research of two-dimensional topological insulator phase [2, 3]. There are, however, relatively few experimental studies, devoted to the properties of one- and zero-dimensional nanostructures made of the above mentioned materials [4].

One of the reason is that II-VI semiconducting alloys are characterized by the high interdiffusion coefficients and the low defect formation energies. Therefore, a relatively low temperatures of pre- and post-processing are required at all technological stages during the nanostructurization phase. For example, the upper limit of 85 °C is recommended for the HgTe quantum well substrates [2]. Such low temperatures, however, are incompatible with the high resolution electron beam resists like a positive tone polymethyl methacrylate (PMMA) or negative tone hydrogen silsesquioxane (HSQ). Both materials require the pre-backing temperatures above 160 °C. Furthermore, the strict temperature limitations pose a serious problem with thermal forming of electrical ohmic contacts in the case of CdMgTe/CdTe modulation doped quantum wells.

Here we report the first results of electron beam lithography processes performed on PMMA and HSQ resists, which have been prebacked *in vacuum* at $T \leq 85$ °C. Data showed that the lithographical resolution is reduced as compared to standard processing, however, the exposure contrast and adhesion to CdTe and HgTe substates were sufficient for the fabrication of submicron quantum devices. Furthermore, the new method of electrical micro-contact forming is proposed. It is based on the on the *local* melting and annealing of an indium metal layer, performed with *the application o electron or ion beams* in scanning electron microscope/ focus ion beam (SEM/FIB) system. The method has been tested for CdTe/CdMgTe quantum wells using the lithograhy techniques, the exposure parameters have been optimized by inspecting the morphology of annealed metal film via the *in-situ* SEM imaging.

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