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Silica-Shielded Ga-ZnS Metal-Semiconductor Nanowire Heterojunctions

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One-dimensional (1D) nanostructures possessing heterojunctions are of particular interest with respect to potential applications in nanoelectronics and nanophotonics [1]. For example, sophisticated light-emitting diodes (LEDs) [2] and diode logic [3-4] devices have been realized while crossing p- and n-type nanowires or using lithography assisted selection of distinct p- and n-type regions within a nanotube [5]. However, compared with a significant progress in nanowire and nanotube preparation in many homogeneous systems, the desired heterojunction formation with well-defined interfaces within 1D nanostructures has been lingering far behind. Most recently, we have reported on the fabrication of new indium-silicon (In-Si) end-to-end nanowire contacts, i.e. metal-semiconductor heterojunctions [6]. Here, we report on the fabrication of Ga-ZnS metal-semiconductor nanowire heterojunctions uniformly sheathed with very thin silica nanotube. The nanostructures are prepared through thermal evaporation of SiO, Ga_2O_3, and ZnS powder precursors followed by desired thermo-chemical reactions. Most of the Ga-ZnS nanowire heterojunctions have diameters of ~ 150-250 nm (a few of them have diameters of ~ 80-120 nm); wall thickness of shielding silica tubes is ~ 4-8 nm. Some nanostructures have a single junction; the others have two or more periodically-located Ga-ZnS junctions (see Figure 1). An interface between Ga and ZnS domains is found to be particularly sensitive to the electron beam irradiation within a transmission electron microscope (see Figure 2). This may open prospects for the design of a unique electron beam - and temperature-driven switch and/or sensor within an electronic device.

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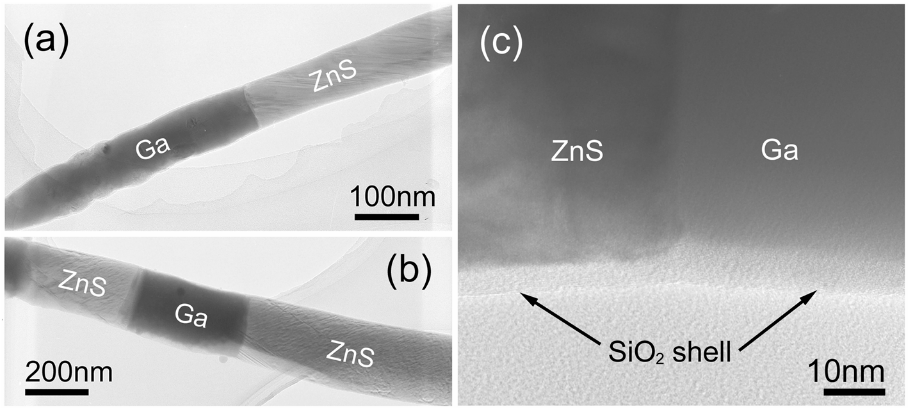

FIG. 1. (a), (b) TEM images shows the Ga-ZnS nanowire heterojunctions having one and two junctions along the length, respectively. (c) High-magnification TEM image shows the Ga-ZnS nanowire junction is homogeneously sheathed with very thin SiO_2 tubular layer.

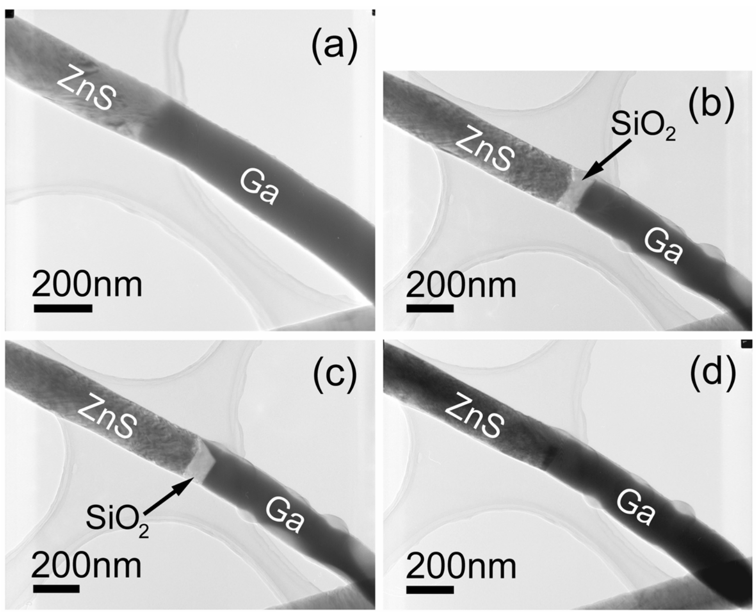

FIG. 2. Consecutive TEM images depicting *in-situ* EBI on a junction area causing the move of a Ga nanowire apart from an original Ga-ZnS junction: (a) before irradiation, (b) cutting junction using a convergent electron-beam (with a size of ~ 200 nm) focused on the junction area, (c) a junction recovery process when the beam is kept away (but still is close to the junction area), and (d) a complete recovery when the beam is placed far away from the junction.

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