Growth and Microstructure of Cored $(Zn_{1-x}Mg_x)O$ Nanorods.

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In recent years, the synthesis and properties of nanostructured materials, such as nanowires, nanorods, and nanotubes, have received much attention. Of particular interest are semiconductors, such as ZnO, where nanoscale devices and quantum confinement effects are possible. In this paper, we describe the synthesis of cored (Zn,Mg)O nanorods, in which a wurtzite phase core is surrounded by a Mg-rich sheath. The nanorods are grown using a catalysis-driven molecular beam epitaxy technique. The process is site-specific, as single crystal (Zn,Mg)O nanorod growth is realized via nucleation on Ag films or islands that are deposited on a SiO_2-terminated Si substrate surface.

The growth experiments were performed using a conventional MBE system. An ozone/oxygen mixture was used as the oxidizing source. The flux of Zn and Mg were provided by Knudsen effusion cells. $(Zn_{1-x}Mg_x)O$ nanorods were nucleated and grown on Si substrates coated with Ag islands for catalytic growth. The growth temperature ranged from *Tg* = 300 to 600 °C using Zn and Mg vapors and O_3 /O_2. Figure 1 shows a TEM bright field image of an individual $(Zn_{1-x}Mg_x)O$ nanorod. Different contrast in the image results from the different diffraction planes or different structures between the core and surrounding material. The nanorod has Mg and Zn cations as determined by TEM-EDS measurements. The structure of a nanorod was investigated using selected area diffraction image of TEM. Figure 2 shows that the nanorod has a single crystal core with a hexagonal crystal structure, surrounded by a polycrystalline sheath possessing the rock-salt cubic crystal structure. Z-contrast STEM indicates that the core is lower in Mg content that the sheath material. This is consistent with a nanorod core possessing the wurzite structure $(Zn_{1-x}Mg_x)O$ surrounded with a Mg-rich (Zn,Mg)O sheath that can be either the rock-salt or wurtzite structure. The (Zn,Mg)O nanorods are cylindrical, exhibiting diameters of 15-40 nm and lengths in excess of 1 μm. The (Zn,Mg)O nanorods exhibit a strong photoluminescence response, showing a slight shift to shorter wavelengths due to Mg incorporation. Microstructures of $(Zn_{1-x}Mg_x)O$ nanorods related to growth conditions will be discussed. In addition, the optical properties will be described

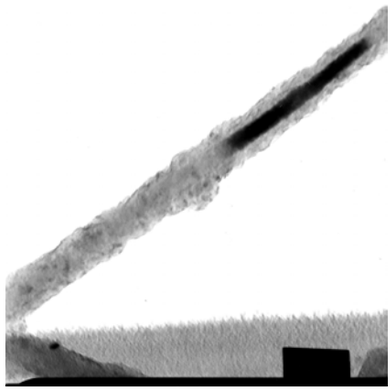

Fig 1. TEM bright field image of cored $(Zn_{1-x}Mg_x)O$ nanorod surrounded by (Mg,Zn)O in the rock-salt structure

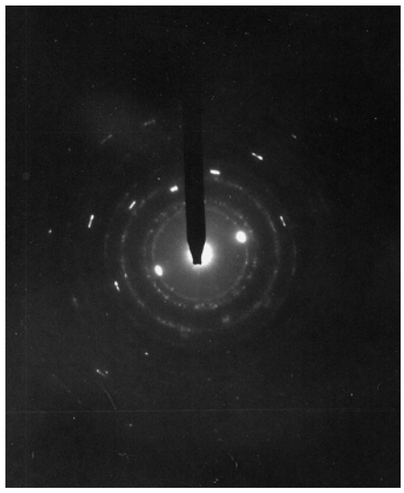

Fig 2. Selected area diffraction image of cored $(Zn_{1-x}Mg_x)O$ nanorod surrounded by (Mg,Zn)O in the rock-salt structure