Oxidation of GaAs Nanowires

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GaAs nanowires have been the most studied III-V semiconductor nanowires due to their unique nanoelectronic and optoelectronic properties. One of the advantages of semiconductor nanowires, is a high surface-to-volume ratio that allows semiconductor nanowires to be used for sensing and photovoltaic applications. In these applications, surface states of semiconductor nanowires become critically important. For this reason, understanding the nanowire surfaces become necessary for their practical applications. Advanced transmission electron microscopy (TEM) has been widely used for determining the structural and chemical characteristics of nanomaterials. In this study, Hitachi HTC has developed a new spherical aberration corrected Cs-STEM (HF5000) that was used to study the cross-sections of individual GaAs nanowires. The cross-sections of individual GaAs nanowires for TEM observations were cut by with an ultramicrotome.

Figure 1 shows a set of S/TEM images simultaneously taken from a typical GaAs nanowire cross-section with (a) secondary electron (SE) image, (b) bright-field (BF) STEM image, and (c) the HAADF-STEM image. The nanowire has a hexagonal cross-section with a thin layer uniformly surrounding its "side-walls". To understand the nature of thin layer and compositional profile of the nanowire cross-section, elemental mapping was performed. Figure 2 shows Ga, As and O maps of the nanowire cross-section. By superimposing the elemental maps shown in Figure 2 with S/TEM images shown in Figure 1, the thin layer surrounded the hexagonal nanowire cross-section can be assigned as the oxidation layer of GaO_x. This study indicates that advanced TEM is a powerful tool in determining the surface behaviors of nanostructures at the nanometer level.

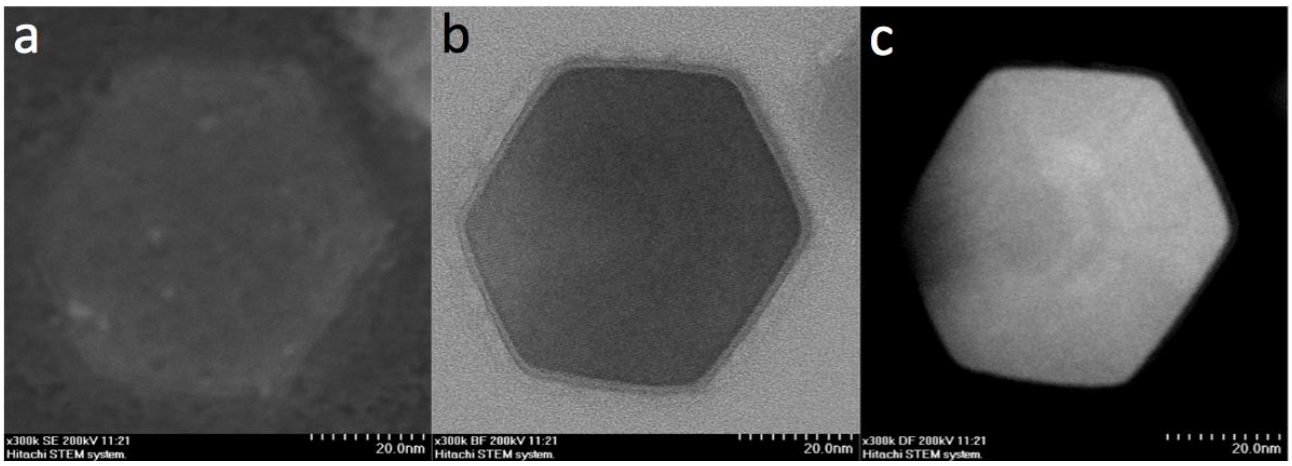

Figure 1 A set of S/TEM images taken from a typical GaAs nanowire cross-section; (a) SE, (b) BF, (c) HAADF.

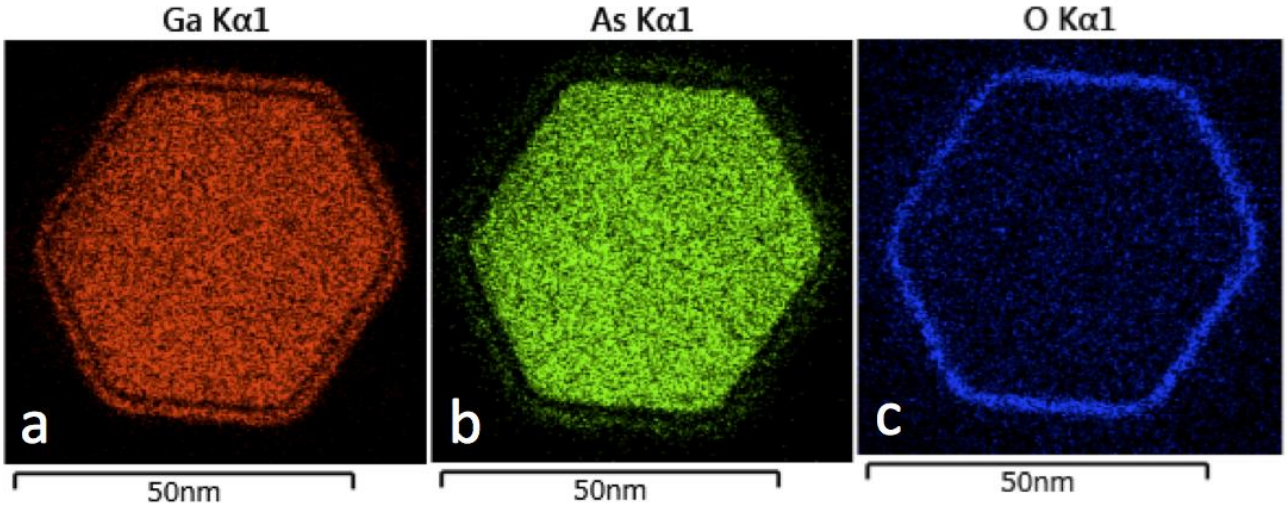

Figure 2 A set of elemental maps from a nanowire cross-section; (a) Ga, (b) As, and (c) O.

Acknowledgements

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