X-RAY ANALYSIS OF VLS-GROWN, VERTICALLY-ALIGNED ZnO NANORODS

Melanie Kirkham, Xudong Wang, Zhong Lin Wang, and Robert L. Snyder
School of Materials Science and Engineering, Georgia Institute of Technology

The purpose of this study is to gain insight into the vapor-liquid-solid (VLS) method for the synthesis of one dimensional nanostructures by characterizing an array of aligned ZnO nanorods with X-ray diffraction. Vertically-aligned, Au-catalyzed ZnO nanorods were grown on an AlGaN layer on an Al_2O_3 substrate using the VLS method. Reciprocal space mapping indicated that the crystallites are well aligned, with a small degree of mosaicity. The AlGaN layer, ZnO nanorods and Au particles were also characterized using X-ray texture analysis, and orientation distribution functions were calculated. The AlGaN layer is oriented with the (0001) planes parallel to the substrate surface. The ZnO is (0001)-oriented, and the Au is {111}-oriented. The Al_2O_3/AlGaN, AlGaN/ZnO and ZnO/Au interfacial planes all have hexagonal symmetry. A possible secondary ZnO {10-11}-orientation is observed with a lattice expansion of approximately 1.43% with respect to the (0001)-oriented ZnO. In addition, the precise Au lattice parameter was determined, and a Vegard's law construction was used to calculate the amount of source material in the catalyst particle. Implications for the VLS synthesis mechanism are discussed. X-ray diffraction is a promising technique for the characterization of arrays of aligned nanostructures. Data is collected from the entire array at once, rather than one nanorod at a time as in electron microscopy, thereby reducing the amount of time required and improving the sampling statistics.