Visualizing the Vapor-Solid-Solid Growth of Wurtzite GaP Nanowires

Tianyi Hu, Pei Liu

Crystal phase engineering in semiconductor nanostructures offers a superior strategy for designing optoelectronic materials with customizable band structures, enhancing device performance and functionality while addressing interdiffusion issues at heterointerfaces and maintaining distinct crystal phase boundaries. This approach is exemplified by gallium phosphide (GaP), which typically exhibits a zincblende (ZB) structure with an indirect band gap of 2.26 eV. Despite GaP's broad optical transparency and compatibility with silicon, its optoelectronic device potential is limited by non-radiative recombination losses. To counter this, attempts have been made to grow wurtzite (WZ) structure GaP with a pseudo-direct bandgap to reduce losses. Traditionally, Au has been used as a catalyst in the vapor-liquid-solid (VLS) method for growing GaP nanowires, but its incorporation into nanowires introduces deep-level traps, leading to the reduction of device efficiency. This study explores the use of Ni as an alternative catalyst for growing WZ GaP nanowires to overcome these limitations. We employed an aberration-corrected environmental transmission electron microscope (ETEM) combined with a metal-organic chemical vapor deposition system (MOCVD) to observe WZ GaP nanowire growth. High-resolution TEM movies and energy-dispersive X-ray spectroscopy (EDS), along with power spectra from HRTEM images, were used to characterize the phases involved in growth. Our findings contribute to the development of more efficient GaP-based optoelectronic devices by providing insights into alternative catalysts for nanowire growth, highlighting the importance of material and methodological innovation in semiconductor research.