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Synthesis and Characterization of Cu(In,Ga)Se2 Nanostructures by Top-down and Bottom-up Approach

Ji-Yeong Lee[1,2], Won-Kyung Seong[1], Myoung-Woon Moon[1], Kwang-Ryeol Lee[1], Cheol-Woong Yang[2,3]

[1]Institute for Multi-disciplinary Convergence of Materials, Korea Institute of Science and Technology, Seoul 130-650, [2]Department of Nano Science and Technology, Sungkyunkwan University, [3]School of Advanced Materials Science and Engineering, Sungkyunkwan University, Suwon 440-746, Korea

Nanomaterials have emerged as new building blocks to construct light energy harvesting assemblies. Size dependent properties provide the basis for developing new and effective systems with semiconductor nanoparticles, quantized charging effects in metal nanoparticle or their combinations in 2 and 3 dimensions for expanding the possibility of developing new strategies for photovoltaic system. As top-down approach, we developed a simple and effective method for the large scale formation of self-assembled $Cu(In,Ga)Se_2$ (CIGS) nanostructures by ion beam irradiation. The compositional changes and morphological evolution were observed as a function of the irradiation time. As the ion irradiation time increased, the nano-dots were transformed into a nano-ridge structure due to the difference in the sputtering yields and diffusion rates of each element and the competition between sputtering and diffusion processes during irradiation.

As bottom-up approach, we developed the growth of CIGS nanowires using thermal-chemical vapor deposition (CVD) method. Vapor-phase synthesis is probably the most extensively explored approach to the formation of 1D nanostructures such as whiskers, nanorods, and nanowires. However, unlike binary or ternary chalcogenides, the synthesis of quaternary CIGS nanostructures is challenging because of the difficulty in controlling the stoichiometry and phase structure. We introduced a method for synthesis of the single crystalline CIGS nanowires in the form of chalcopyrite using thermal-CVD without catalyst. It was confirmed that the CIGS nanowires are epitaxially grown on a sapphire substrate, having a length ranged from 3 to 100 micrometers and a diameter from 30 to 500 nm.

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