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Simultaneous Anion and Cation Exchange Processes for the Growth of Novel Optoelectronic Structures

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Abstract

We have demonstrated simultaneous anion and cation exchange processes to grow novel optoelectronic structures that are unlikely to be grown directly. While separate anion or cation exchange process has been demonstrated before, this is the systematic demonstration of simultaneous exchanges of both anions and cations. In this study, we particularly focus on ZnCdSSe quaternary alloys and CdSe-rich alloys provided an appropriate starting material for morphology transfer through simultaneous dual-ion exchange processes to obtain ZnS/Se-rich ZnCdSSe nanosheet structures. This mechanism is very promising to grow a variety of structures not possible to be grown directly with desired morphology and composition combinations.

Keywords: semiconductor, optical materials, nanostructured materials, chemical vapor deposition (CVD), cation-anion exchange.

1. Introduction

Synthesis of new nanoscale heterostructures has attracted a great deal of interest due to their superior electronic and photonic properties [1-7]. Such structures are usually grown by altering the reactant precursors with time or by changing the growth conditions [1,5-8]. For various reasons such as dissimilar vapor pressures of constituent elements, mismatch between growth kinetics and dynamics of the materials, extreme growth conditions and so on [9-16], it is not always possible to obtain a desired morphology with a given material composition directly. Such desirable morphologies may be obtained through the process of morphology transfer, in which materials amenable to growing with the desired morphology are first grown and then replaced with the desired alloy compositions through cation or anion exchange [9-16]. Through