Insights into Raman spectra and doping concentration profiles of Eu-doped {ZnCdO/ZnO} superlattices

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ZnO is a commonly known semiconductor compound that has found application in various types of optoelectronic devices, such as lasers, diodes, and photodetectors. In photovoltaic cells it is used as a transparent conducting film, due to its wide band gap (ca. 3.37 eV at room temperature [1]) and low resistivity [2].

In high-efficiency thin film solar cells absorber layer can consist of several layers, each of them suited to absorbing a specific energy range of photons. In this case, ZnO could be in control of UV light conversion. To expand its possibilities towards shorter wavelengths, we propose ZnCdO alloy, as CdO has an energy gap of 2.24 eV [3]. The remaining key component of the presented samples is europium (Eu). Both ZnO and CdO has been successfully doped with this rare-earth metal, giving rise to a huge improvement in carrier concentration and mobility, which is desirable in terms of future applications [4, 5].

Eventually, we decided to use superlattice (SL) structure type grown by molecular beam epitaxy to strictly control composition of the final material. Moreover, in SLs it is possible to modulate the energy gap simply by changing thickness of a sublayer, which is also a promising feature [6]. Thus, in this work we would like to present first Eu-doped {ZnCdO/ZnO} SL structures. Raman spectroscopy (Fig. 1.) has revealed additional modes, dopant-related ones, forbidden in bulk ZnO, that occur in doped ZnO films. Furthermore, post-growth treatment analysis showed that annealing cause significant modifications in Raman spectra associated with changes of impurity content. Additionally, p-n junctions with the aforementioned SL structures were prepared on silicon substrates to be able to perform electrical measurements. Current-voltage characteristics shown the obtained samples are functioning diodes with a rectifying p-n junction. Capacitance-voltage measurements helped to determine dopant concentration and its distribution within the junction depletion region. To the best of our knowledge, there are no results of studies reporting observation of Eu dopants in Raman spectra and doping concentration profiles of Eu-doped {ZnCdO/ZnO} superlattice structures.

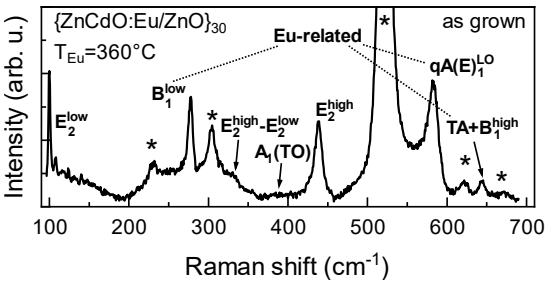

Fig. 1. Raman spectrum of one of the samples with various ZnO modes. Si substrate modes are marked with an asterisk.

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