Epitaxial growth of cuprous oxide by molecular beam epitaxy and electrodeposition

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Cuprous oxide (Cu2O) is promising material as a p-type semiconductor for solar energy applications. However, the performances of solar cells and thin film transistors based on Cu2O are mostly inferior to expectation up to now. The reason responsible for the poor performance of the Cu2O-based devices may be the fine-grained microstructure in which abundant grain boundaries act as recombination centers for electrons and holes. As a result, fabricating devices made from high quality Cu2O epitaxial layer shall elucidate the reason. Various methods have been used to grow Cu2O epilayers including molecular beam epitaxy (MBE), chemical vapor deposition and electrochemical deposition. In this study, studies on epitaxial growth of cuprous oxide on copper by MBE and on copper and silver by electrodeposition were carried out using an ex-situ method to study the orientation dependence of epitaxial growth. In this method, the substrates were polycrystalline and the substrate grain orientation was characterized by electron backscatter diffraction (EBSD) technique prior to deposition. The orientation distribution of the deposited films in the prior-analyzed area was characterized again after deposition by EBSD to reveal the orientation relationship between each deposit/substrate pair. Results indicated that Cu2O preferred to grow epitaxially on {110} and {111} oriented grains with a cube-on-cube orientation relationship by MBE. Moreover, Cu2O can be grown epitaxially on all silver grains by electrodeposition with the same orientation relationship. For copper substrates, an additional orientation relationship of <100>/45o was found between some epilayers and the underlying grains. Room temperature photoluminescence spectra showed that the epilayers grown by electrodeposition exhibited a strong near-band emission at approximately 1.95 eV.