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Growth Characterization of MOCVD AlGaAs Alloy System

M. Mizuta, F. Moriyama, S. Kawata, T. Iwamoto and H. Kukimoto

Imaging Science and Engineering Laboratory,
Tokyo Institute of Technology, Nagatsuda,
Midori-ku, Yokohama 227, Japan.

MOCVD (Metal Organic Chemical Vapor Deposition) has been recognized as one of the most promising techniques to realize quantum size devices involving various alloy heterostructures. The abruptness of the heterointerface has been reported to be less than 20A in the case of GaAs/AlGaAs system using TMGa and TMAl as source materials. We believe that the speed of the MO-carrying gas and the transport rate of the group III atoms are two main factors which determine the abruptness of the interface. To date, in almost all reports, trimethyl compounds have been utilized in spite of their high vapor pressure which inevitably requires a small flow rate of the MO-carrying gas in the growth of ultrathin layers. If low vapor pressure triethyl compounds are used as source materials, one can be benefited in possible higher flow rate and simultaneously in a lower transport rate of group III atoms, which corresponds to a lower growth rate. Therefore, higher abruptness could be realized by the utilization of triethyl compounds. There have been, however, very few reports of describing the MOCVD growth by triethyl compounds. In this paper, we present experimental data of MOCVD AlGaAs growth by the combinations of TEGa/TEAl, TEGa/TMAl and TMGa/TMAl to show a full possibility of using triethyl compounds and to verify the growth behavior for different source material combinations.

The growth rates of GaAs and AlAs using TEGa and TEAl have been found to be 100-200A/min and 10-80A/min at bubbling flow rates of 60-150sccm and 60-450sccm, respectively. These should be compared to the growth rates of 300-1500A/min (GaAs) at

3-15sccm and 100-600A/min (AlAs) at 3-15sccm for the cases of TMGa and TMAl, respectively. Although the normalized growth rate of GaAs by TEGa (growth rate per transported mole fraction of Ga) has been reported to be much smaller by an order than that by TMGa, our results have shown that they are comparable (by a factor of 0.7) and this difference can be explained by the difference between velocities of TEGa and TMGa in the boundary layer formed on the substrate. A low pressure reactor system, which we have employed, is expected to avoid any undesirable reactions between source gases and this may be the reason why we could achieve a comparable normalized growth rate using TEGa.

By the use of TEGa and TEAl, we have successfully grown AlGaAs alloy with high photoluminescence quality. It has been shown that even by a non-thermal equilibrium growth technique like MOCVD there exists a characteristic distribution coefficient between gas and solid phases. We will discuss the results of different distributions of Ga or Al for the cases of methyl and ethyl alkyl compounds.

Discussion also includes the results of light emission from the QW structure of AlAs/GaAs system produced by a combination of TEGa and TEAl.