High Temperature Effects in Metal-Organic Vapor Phase Epitaxy of GaN and AlGaN

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One of the main features of III-nitride growth is quite high (compared to conventional III-V's) deposition temperature. The typical GaN and AlGaN growth temperatures are about 1100°C and even higher. Experimental studies [1-3] show that an increase of the temperature above some critical value promotes rapid decrease of the GaN growth rate, but the onset of this decrease is dependent on reactor type and operating conditions and may vary from 1000 °C [1] to 1100 °C [3]. Similar trends are observed in MOVPE of AlGaN where the layer composition is quite sensitive to temperature variations [4]. High temperatures are always preferable with respect to material quality and therefore it is desirable to shift to higher temperatures without drastic decrease of the growth rate and without loss of layer composition control.

In this paper we present the results of modeling study of high temperature effects in MOVPE of GaN and AlGaN. It is shown that decrease of the growth rate is related to intensive desorption of gallium from the growing surface. The latter is accounted for in the original model of surface chemistry [5], which is linked with mass transport calculations performed using commercial computational fluid dynamics code CFD-ACE +™. The effect of different operating parameters such as reactor pressure, V/III ratio, group III precursor flow rate on high temperature deposition behavior is studied.

Effects of surface chemistry on aluminum incorporation in AlGaN are illustrated in Figures 1-2. At high temperatures, desorption of gallium becomes significant and results in depletion of the growing layer with gallium. Intensive gallium desorption may be suppressed by increasing total group-III flow (growth rate).

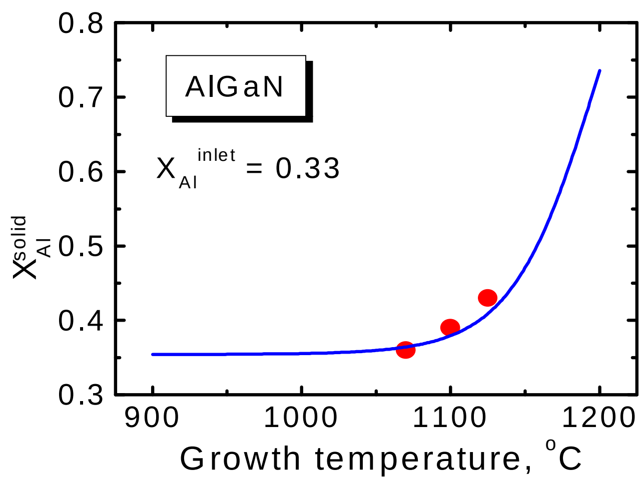

Figure 1. AlGaN solid composition versus substrate temperature. Solid line corresponds to model predictions; points are the experimental data from [4]

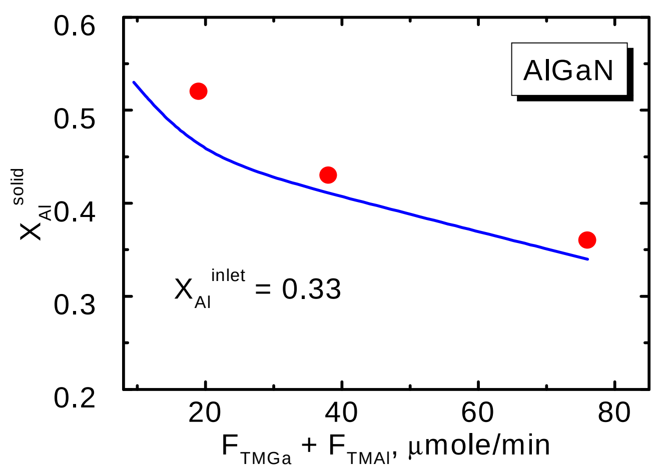

Figure 2. AlGaN solid composition versus total group III flow rate. Solid line corresponds to model predictions; points are the experimental data from [4]

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