MATERIALS SCIENCE COLLOQUIUM

SPEAKER: FAN JIANG
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TITLE: Observing MOCVD Growth of III-Nitrides Using X-Rays

DATE: Thursday, June 21, 2007

TIME: 11:00 a.m.

PLACE: Building 212, Room A-157

HOST: Maria Iavarone

Refreshments will be available at 10:45 a.m.

Abstract:
One of the fundamental issues in the continued development of III-nitride semiconductor alloys is to understand incorporation of indium. Our approach is to use real-time x-ray scattering and fluorescence as in situ probes during growth by MOCVD. Under typical conditions for InGaN growth, we observe the equilibrium condensation boundaries for elemental In and InN as a function of temperature and trimethylindium supply, which allow us to determine the effective activities of In and N at the sample surface. We find that the partial pressures of both hydrogen and ammonia in the ambient have strong effects on the activities. We also find that MOCVD of InN on GaN can be inherently unstable, spontaneously cycling between growth and decomposition. Depending upon NH3 and TMI supply and temperature, different wave patterns due to cyclic growth are observed on sample surfaces, such as linear fronts, expanding circular disks, and spirals. Such self-sustaining spatio-temporal oscillations have been previously observed in systems known as excitable media, including chemical reactions in solution, heterogeneous catalysis of molecular reactions on surfaces, and cardiac muscle. The observed oscillatory MOCVD process represents a new type of excitable media, involving transformations between solid, liquid, and vapor phases. The results will be discussed in terms of a model in which the effective nitrogen activity produced by catalytic decomposition of NH3 on the surface depends on the amount of InN and In liquid present. Work supported by the U.S. Dept. of Energy contract DE-AC02-06CH11357.