In Situ X-ray Characterizations of Bismuth Electrodeposition under Different Nucleation Mechanisms

Xin Huang1,2, Manuel Plaza1,2, J. Y. Peter Ko3, Joel D. Brock1,2,3
1 School of Applied and Engineering Physics, Cornell University, Ithaca, NY 14853, USA
2 Energy Materials Center at Cornell, Cornell University, Ithaca, NY, 14853, USA
3 Cornell High Energy Synchrotron Source, Cornell University, Ithaca, NY, 14853, USA

We report the *in situ* synchrotron X-ray diffraction study on bismuth (Bi) epitaxial electrodeposition on GaAs (110) under different nucleation mechanisms, and study the corresponding crystal structure of the deposited film.

The nucleation mechanism of Bi on GaAs is changed with biased potential: kinetic-control nucleation at negative biased potential smaller than -100mV vs. Ag/AgCl and kinetic-diffuse mixed control nucleation at the negative biased potential larger than -100mV vs. Ag/AgCl, and with more negative biased potential, the nucleation mechanism is approaching to diffuse control regime.

As the system approaching to diffuse-control regime, Bi film tends to form single oriented domain film with (1 0 8) as surface normal plane. However, at the kinetic-control regime, Bi forms three different oriented single crystal domains. The surface normal plane of the three domains is (1 0 8), (1 0 14) and ($\bar{3}$ 10 34). Among the three domains, the (1 0 8) domain has similar in-plane structure as the (1 0 14) domain, but with different tilt angle between $(0\ 0\ 1)_{Bi}$ and $(1\ 1\ 0)_{GaAs}$ planes. With the increasing growth potential, the ratio of the (1 0 8) domain over the other domains increases. In addition, as the nucleation mechanism changes from the kinetic-control to the mixed control, the crystal mosaicity of the film decreases (The mosaicity of the film grown under -90mV vs. Ag/AgCl is 6 times larger than that of the film grown under -200mV vs. Ag/AgCl).