SESSION A2: SYMPOSIUM OF THE DIVISION OF CONDENSED MATTER PHYSICS: EPITAXY INDUCED STRUCTURES

Monday morning. 20 March 1989; Room 132 at 9:12; A. Zangwill, presiding

9:12

A2 1 Stabilization of Epitaxial Structures. **DAVID M. WOOD,** *SERI.*

Phenomena peculiar to coherent epitaxial growth of alloys include: (i) ordered compounds not present in the bulk phase diagram; (ii) constituents insoluble in bulk below a miscibility temperature T_{MG} become epitaxially soluble even 1200 "C lower; (iii) the pinning of the measured composition x of an **epitaxial** alloy near where the alloy is lattice matched to the substrate ('lattice latching' or pulling'), while the composition x of a **bulk** alloy grown under identical conditions varies widely. A simple picture of epitaxial energetics makes clear the origin of these effects. A cluster-based theoretical description permits prediction and quantitative comparison of bulk and epitaxial (x,T) phase diagrams for the same system. It also places the common phenomenological treatment of an alloy as an elastic continuum on a microscopic footing (and highlights its inadequacies!). Results will be given for (a) $Cu_{1-x}Au_x$, a typical 'ordering' alloy (with stable stoichiometric compounds in bulk) and (b) the isovalent semiconductor $GaAs_xSb_{1-x}$, a typical Phase separating' alloy (insoluble until entropy dominates above T_{MG}). All of the effects above emerge naturally from our treatment; we trace them to the lattice mismatch between the alloy constituents, not to mismatch with the substrate. A simple expression relates the degree of composition pinning to the epitaxial suppression of the miscibility temperature. Using an epitaxial generalization of a recent thermodynamic treatment of bulk molecular beam epitaxy growth of $A_{1-x}B_xC$ isovalent semiconductors[3] we demonstrate that composition pinning should be observabfe here as well. Substrate orientation and film thickness effects will also be discussed.

[1] D. M. Wood and Alex Zunger, Phys. Rev. Lett. 61, 1501 (1988).
[2] D. M. Wood and Alex Zunger, Phys. Rev. B38 (in press).
[3] H. Seki and A, Koukitu, J. Cryst. Growth 78, 342 (1986).