07.X-12 SURFACE RECONSTRUCTED STRUCTURES STUDIED BY UHV-ELECTRON MICROSCOPY AND DIFFRACTION. By K.Takayanagi, Department of Physics, Tokyo Institute of Technology, Meguro-ku, Tokyo, 152 Japan.

Structural studies of the reconstructed surfaces and adsorbed layers by UHV-electron microscopy and diffraction are reviewed, with a recent high resolution microscope(HREM) observations. To analyse suface and adsorbed structures, 1)Bright- & dark-field microscopy combined with transmission electron diffraction (TED) and 2)HREM has been utilized for clean & well-defined specimens prepared in-situ in UHV elec tron microscopes. In transmission mode, diffraction of the electrons in a thin surface layer can be approximated by the kinematical theory, so that the interpretation of the image contrast and diffraction intensity can be made straightforwardly using Fourier transform, in contrast to LEED and RHEED. By TED, for example, the Si(111)7x7 reconstructed structure has been solved using the "partial" Patterson and Fourier syntheses and the reliability factor analyses. HREM can give atomic arrangement at the surfaces more directly, although careful image interpretation has to be made because of the resolution limitation. Atomic arrangements of the Au(100)5x1, (110)2x1 and (111)22x1 structures have revealed by the profile imaging using a new high resolution UHV microscope of 200kV acceleration. HREM in reflection mode has also revealed structural details of the Si(111)7x7 and (100)2x1 surfaces, and of dynamical motion of surface steps during deposition of Au, Ag, Al or Cu on the Si(111)7x7 surface. Surface structures thus studied are summarized in Table 1.

Table 1. Semiconductor and Metal Surface Structures

surface -adsorbate	structure	method	remarks
Si(111)	7x7	TED	DAS model
	7x7	REM-RHEED	surface step & topograph
	7x7	TEM	7x7 superlattice fringes
Si(111)-Ge	5x5, 7x7	REM,TEM	structures similar to DAS
Si(111)-Au	5x2streak	TED-TEM	
	3diffuse		trimer model
	6x6	REM-RHEED	
Si(111)-Ag	3x 3,3x1	TEM-TED	atomic structure analysis
		REM	3x 3 nucleate at step
Si(111)-Sn	3, 2 3	REM,TED	structural analysis
Si(111)-Cu	incommensurate		Cu nucleate at upper
	rotational epitaxy		side of steps. diffusion
		REM,TED	of Si atoms.
Si(111)-Al	incommensurate		Al nucleate at steps
Si(001)	2x1	TED	bilayer step formation
		REM	monolayer& bilayer steps
Au(111)	px1(p-22)	TEM-TED	contraction of - 4%
	28x28		high temperature phase
	"30x30"		metastable structure
Au(001)	28x5	TEM-TED	28x5 superlattice image
	1x5	HREM-TEM	profile image
Au(110)	2x1	HREM-TEM	profile image
Ag(111)	1x1	TEM-TED	monatomic high step
			layer-by-layer growth
		HREM-TEM	plan-view image
Pb(111)	1x1	TEM-TED	monolayer high steps
Au(111)-Ag	1x1	TEM-TED	layer-by-layer growth
-Pb	3x 3	TEM-TED	domain foemation
	twist		close-packed (111) layer
-Cu			islands with MD#
-Fe			pseudomorphic growth
Ag(111)-Au	"30x30"	TEM-TED	island(2-3layers?)
-Pb	3x 3		domain formation
	twist		close-packed (111) layer
Pb(111)-Au	Au_2Pb		monolayer of Au_2 Pb
-Ag			islands with MD
			(interdiffusion?)
Pd(111)-Au		TEM-TED	monolayer dendrite
-Ag			monolayer islands with MD

MD:misfit dislocation formed at interface between deposit and substrate

07.X-13 STRUCTURE AND OPTICAL PROPERTIES OF ARTIFICIALLY ORDERED Ge-Si SUPERLATTICES. By J. Bevk, AT&T Bell Laboratories, Murray Hill, New Jersey, USA.

Recent advances in thin film techniques now make it possible to synthesize solid state structures not obtainable by any conventional growth procedures. Classic examples include lattice-matched, layered semiconductor superlattices and, more recently, strained layer structures. The ultimate limit in the latter case is the synthesis of strained layer epitaxial structures with the lattice periodicity on the order of a few monolayers. Such "unit-cell engineering" permits formation of artificially ordered simple and complex-cell superlattices and of one-dimensional quasi-periodic heterostructures. These materials exhibit a variety of interesting properties attributed to band structure modifications due to strain, reduced physical dimensions, and artificial (quasi)periodicity on a monolayer scale.

This talk will focus on the synthesis, structural characterization and optical studies of ultrathin Ge-Si superlattices, grown by molecular beam epitaxy on Si, Ge and GaAs substrates. Structures consist of alternating layers of pure Ge and Si, with layer thicknesses of 1, 2, 4, and 6 monolayers (J. Bevk et al., Appl. Phys. Lett. 50(12), 1987; ibid., 49(5), 286 (1986)). Because of the large lattice mismatch (4.2%) between Si and Ge, the choice of the substrate determines the strain in the individual sublayers and indirectly the band structure and optical properties of the superlattices. Using x-ray techniques and high resolution transmission electron microscopy, we provide direct observation of order in these pseudomorphic layered films. Systematic study of optical transitions by means of Schottky barrier electroreflectance reveals that each of the ordered structures displays a unique set of optical transitions. Of particular interest is the 4x4 structure which shows new, well defined direct optical transitions at 0.76, 1.25 and 2.31eV. These transitions constitute the first observation of structurally induced optical transitions in Ge-Si and may make the 4x4 structure suitable for opto-electronic devices.