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PHOTOEMISSION SPECTROSCOPY ON AMORPHOUS SEMICONDUCTORS AND THEIR INTERFACES

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In recent years there was an increasing interest in the properties of tetrahedrally-bonded amorphous semiconductors. We have applied photoemission techniques for investigating their electronic structure and the microscopic parameters of the interfaces that can be formed with them. The materials investigated were amorphous Si and Ge (both hydrogenated and not) and silicon-germanium and silicon-carbon alloys. The samples were prepared by evaporation or glow-discharge techniques. The heterojunctions were grown in situ step by step and studied at each intermediate coverage.

In Table I the measured valence-band discontinuities ΔE_v and the optical gap Eg of the two semiconductors forming the heterojunctions are reported. Also reported are the conduction-band discontinuities ΔE_c estimated by using ΔE_v and Eg. The heterojunctions can be divided in two groups. The first one includes heterojunctions between amorphous silicon and germanium or silicon-based alloys. They have an immediate inter-

TABLE I

Substrate/Overlayer	Eg(Subst.) (eV)	Eg(Overl.) (eV)	ΔE_v (eV)	ΔE_c (eV)
a-$Si_{1-x}C_x$:H/a-Si	2.2[1]	1.26[2]	0[3]	0.9
a-$Si_{1-x}C_x$:H,B/a-Si	2.05[1]	1.26[2]	0[3],.15[4]	0.65-0.8
a-$Si_{1-x}C_x$:H,B/a-Si:H	2.05[1]	1.7[1]	0[4]	0.35
a-Si:H/a-Ge	1.7[1]	0.7[5]	0.2[6]	0.8
a-Si/a-Ge	1.26[2]	0.7[5]	0[6]	0.54
a-Si:H/a-Si	1.7[1]	1.26[2]	0[3]	0.44

est for the application in solar cells and multilayer structures. In the second category we can group pseudo-heterojunctions obtained by growing an amorphous overlayer of a given material on a crystalline or hydrogenated-amorphous substrate of the same material. In this way it is possible to investigate fundamental problems like the effect of disorder and/or hydrogenation on the electronic structure of the materials.

We found that heterojunctions between amorphous silicon and silicon-based alloys exhibit negligible valence band discontinuities for not too high a value of x. This behavior is explained in term of the large compositional disorder present in the alloys.

The most important implication of our experiments on c-Si/a-Si and a-Si:H/a-Si is that neither the disorder nor the hydrogenation affect the position in energy of the valence band edge. This indicates that the hydrogen induced widening of the optical gap is primarily due to a shift in energy of the conduction band edge.

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