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MEASUREMENT OF THE SUBBAND WIDTHS IN SEMIMETALLIC InAs–GaSb SUPERLATTICES

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The three-dimensional character of a superlattice manifests itself through the finite subband width of the subbands. Superlattices made from InAs and GaSb have fairly wide subbands (~20 meV) even for layer thicknesses in excess of 100 Å [1] due to the specific nature of the subband formation in these superlattices (i.e. the interaction between the InAs-CB with the GaSb-VB, which is 150 meV higher in energy) and the light effective mass of InAs-CB. In addition this peculiar band line-up leads to a hole subband higher in energy than the lowest electron subband for InAs layer thicknesses > 100 Å [2] and therefore to a semimetallic character of these superlattices.

Far-infrared magnetotransmission experiments of two semimetallic samples (S1 = 120 Å/80 Å and S2 = 200 Å/100 Å for the InAs and the GaSb layer thicknesses respectively) at several fixed far-infrared frequencies as a function of the magnetic field, show cyclotron resonance and transitions between the valence and the conduction subband. Two sets of interband transitions, one at $k = 0$ and one at $k = \pi/d$ (d is the superlattice periodicity) are observed, because both these points in the superlattice Brillouin zone correspond to maxima in the subband density of states. Extrapolation of the $k = 0$ transition energies as a function of the magnetic field to zero field gives the energy gap, which is negative in this case due to semimetallic character of the samples. The difference between the extrapolated values at zero magnetic field for the $k = 0$ and the $k = \pi/d$ transitions gives directly the width of the electron subband. In this way electron subband widths of 21 meV and 16 meV are measured for S1

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and S2 respectively. These measured values are in close agreement with calculations.

This observation demonstrates directly the three-dimensional character of the superlattice, because a finite subband width is a unique consequence of the interaction between several layers of the superlattice materials as oposed to a flat subband for a simple quantum size effect.

References

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