Optical and Electrical Properties of PbTe-$Pb_{1-x}Sn_xTe$ Superlattices Prepared by a Hot Wall Technique

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PbTe-$Pb_{1-x}Sn_xTe$ superlattices ($x \cong 0.2$) were grown for the first time on BaF_2 substrate at the substrate temperature between 250 and 300°C by a hot wall technique, and their optical and electrical properties were investigated. The atomic compositional profile of PbTe -$Pb_{1-x}Sn_xTe$ superlattice composed of alternating layers of 100, 200 and 400Å and another annealed superlattice were analyzed by the Sputtering-Auger method and were found to be well-controlled periodic structure with slight interdiffusion of Pb and Sn atoms.

The optical properties of PbTe-$Pb_{1-x}Sn_xTe$ superlattices were measured at 77K and the quantum size effects of electronic system in $Pb_{0.8}Sn_{0.2}Te$ layers were observed and analyzed. In this analysis the Kronig-Penney model was used taking into account of non-parabolicity and<111>many valley structure of energy band, and a good coincidence between the theoretical and experimental values was obtained. Considering the electronic properties of PbTe and $Pb_{0.8}Sn_{0.2}Te$, the fundamental absorption edges observed at 77K were best fitted to the energy separation between the ground states of the light hole and those of the light electron where the optical transitions occur. On the other hand, the interband absorptions related to the heavy holes and heavy electrons were found through the measurement at 150K.

The two dimensional conductivity of electrons and holes were measured in the modulation Bi doped PbTe-$Pb_{1-x}Sn_xTe$ superlattices. The magnetic field direction dependence of the Shubnikov-de Haas oscillation and the magnetoresistance anomalies measured at 77K were explained as two dimensional conductivity phenomena.

We have prepared (p/n) PbTe multiple-layer films and get the low carrier density films with $n \simeq 5 \times 10^{16} cm^{-3}$. The high sensitive photoconduction effects were observed in these low carrier density films with the electric current perpendicular to the layers.