Transport properties of n- and p-type polycrystalline $BaSi_2$

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Abstract. Electron and hole mobilities versus temperature in semiconducting barium disilicide ($BaSi_2$) have been systematically studied both experimentally and theoretically. The experiments were performed with undoped 250 nm-thick $BaSi_2$ polycrystalline films grown by molecular beam epitaxy. The grain size of films ranged from 0.2 to 5μm with the electron concentration of 5.0×10^{15} cm^{-3}. To investigate the hole mobility, B-doped *p*-$BaSi_2$ films with various dopant concentrations were fabricated and studied. The experimental temperature dependence of the electron mobility in the range of 160–300 K was found to have a maximum of 1230 $cm^2/V\cdot s$ at 218 K, while at room temperature (RT) it dropped down to 816 $cm^2/V\cdot s$. We demonstrate that the temperature dependence of the electron mobility cannot be adequately reproduced by involving standard scattering mechanisms. A modified approach accounting for the grained nature of the films has been proposed for the correct description of the mobility behavior. The highest hole mobility in *p*-$BaSi_2$ films reaching ~ 80 or 200 $cm^2/V\cdot s$ (for the films grown on (111) or (001) Si substrates, respectively) at RT is about an order or four times of magnitude smaller than that in *n*-$BaSi_2$ films. Such a great difference we ascribe to the specific features of electron-phonon and hole-phonon coupling in semiconducting $BaSi_2$.

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