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RBS-Channelling analysis into the effect of thermal annealing on GeSn strained layers

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Abstract content
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Alloying Ge with Sn improves carrier mobility and can also transform the material from an indirect bandgap into a direct bandgap semiconductor. Unfortunately α-Sn is only stable at temperatures <13deg;C and this, coupled with the large mismatch between Sn and Ge, results in an upper limit of Sn in Ge of around 1%. It is possible to produce alloys with the higher Sn concentrations but these alloys are metastable and can relax on thermal annealing. Rutherford Backscattering Spectrometry and channelling have been employed to investigate the effect of thermal annealing on epitaxial GeSn (6.5% Sn) strained layers grown on Ge-buffered Si(100) wafers, with channelling along the [110] axis being used to investigate the strain residing in the layers upon thermal annealing. Annealing at temperatures below 400deg;C for 20 minutes had no noticeable effect on the strain in the epitaxial layers. Once the temperature was raised above 400deg;C however, relaxation of the layer sets in and the GeSn layer has essentially completely relaxed following a 20 minute anneal at 650deg;C. The results are in good agreement with similar investigations conducted using X-ray diffraction. The advantage of the RBS/Channelling approach however, is its ability to provide compositional information as a function of depth. One is therefore able to monitor the effect of the thermal anneal on the Ge and Sn distribution throughout the layer, and also to extract information about their lattice location. The results obtained show that that when the initial relaxation sets in both the Ge and the Sn are still situated in substitutional sites, and it is only around 600deg;C after substantial relaxation has taken place that the Sn is ejected from the lattice sites and diffuses to the surface of the sample.

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