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Investigation of GeSn thin films using Real-Time and RBS channeling techniques at iThemba LABS

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Alloys of Group IV element, C, Si, Ge and Sn, have received significant interest in electronic industries due to unique and intriguing (Opto) electronic properties for these alloys as theory predicts. Significant alteration of the band structure causing indirect-to-direct transition of the band gap and increased mobility in the strained Ge thin film has been theoretically predicted for Ge alloyed with Sn triggering 13% lattice mismatch. Unfortunately the diamond structure of α-Sn is unstable above 13oC making it difficult to incorporate Sn in the Ge, and the Ge-Sn phase diagram predicts very little immiscibility, in fact limiting thermodynamically stable Sn incorporation to about 1%, which is too low to cause the desired properties. Despite these constraints careful preparation by MBE and CVD has enabled alloy levels of around 10% to be achieved.
Up until now much of the attention has gone into understanding the growth mechanism and properties of the as-grown strained GeSn films. Integration of these strained films into advanced electronic devices will also expose them to thermal treatments and to metallization, which may alter the stability of these metastable films. We have investigated the stability of Sn in GeSn thin films grown on Ge by using real-time RBS during a ramped thermal anneal to monitor their thermal stability during a thermal treatment. Real-time RBS has also been used to monitor the effect of metallization on the stability of Sn in the GeSn layer during their reaction with Ni and Co. RBS / channelling have also been used to establish if any relaxation occurs in the strained metastable films. According to the results the Sn in the GeSn film is stable up to at least 600oC. Reacting GeSn with Co reduces stability of Sn in the CoGeSn ternary formed and around 360oC the Sn atoms diffuse to the surface. Channelling measurements indicate that the GeSn strained layer relaxes during the thermal anneal.

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