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Real-time XRD/RBS study of platinum germanide formation on Ge<100> and Ge<111> substrates

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Abstract content
 (Max 300 words)

The dominance of silicon as the primary semiconductor of use in the microelectronics industry owes much of its popularity to the stability and the ease of processing its oxide, SiO₂, which is extensively used for the gate dielectric in devices. With the continuous drive for greater performance SiO₂ is however slowly being replaced by superior high-dielectric constant materials. This in turn opens up the opportunity of replacing silicon by a better performing semiconductor such as germanium. However, before germanium can be adopted by the industry a suitable contact material must be identified to make electrical contact to the active areas of the transistor. The contact material is likely to be a metal-germanide, compounds formed by reaction of Ge with a suitable metal.

The work describes a study of the Pt/Ge system using real-time X-ray diffraction and real-time Rutherford backscattering spectrometry. Although it is unlikely to be used by industry the Pt/Ge system is nevertheless of considerable scientific interest. Four distinct germanide phases (Pt₃Ge₂, PtGe, Pt₂Ge₃ and PtGe₂) form sequentially when a thin Pt film deposited on a Ge substrate is thermally annealed, making it one of the most complex germanide systems. Several of these phases grow epitaxially on Ge<111> substrates i.e. the orientation of the grains formed during germanide growth is aligned with the substrate orientation. The epitaxial growth of these layers is found to give rise to “epitaxial stabilisation”, which delays the conversion of one phase to the next. Furthermore the onset of formation of some phases appear to be nucleation controlled which gives rise to different growth mechanisms. Studying the reactions in real time during a ramped thermal anneal allows one to probe the full response to the thermal treatment in a single run. Apart from the efficiency achieved by real-time techniques one also avoids the risk of overlooking small but important stages of the reaction, as one might well do using the more conventional “cook and look” approach.

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