KINETICS AND ENERGETICS OF GE CONDENSATION DURING SIGE THERMAL OXIDATION

David Thomas, Benkouider Abdelmalek, Aqua Jean-Noel, Cabie Martiane, Favre Luc, Neisius Thomas, Abbarchi Marco, Naffouti Meher, Ronda Antoine, Liu Kailang,
Isabelle Berbezier

During the last years Silicon Germanium on insulator layers were under intense scrutiny due to their promising applications for ultra-scales MOS transistors with relevant properties. The aim is to pursue the Moore's law by developing planar transistors based on ultra-thin Silicon Germanium on insulator (UTSGOI) systems. One major hurdle is the fabrication process of the strained Silicon–Germanium (or pure Germanium) layers on insulator (SSGOI). While these layers are already used as vehicle tests for the next generation of transistors (node 14nm), the formation of the Ge rich layer (GRL) by condensation during SiGe thermal oxidation is still misunderstood. For the first time we fully demonstrate the mechanism of Ge rich layer formation by a combination of experimental results and theoretical demonstrations. We use two systems with similar SiGe concentration but different initial strains and we demonstrate two fabrication routes of SSGOI with different concentrations and configurations depending on the oxidation temperature. At low temperature, we show that $SiGe_{0.5}$ is stabilised by the combined effects of a local minimum of energy and a kinetic barrier. The cornerstone of the formation process is the minimum enthalpy formation of the $SiGe_{0.5}$ alloy whatever the strain level is. At high temperature, the kinetic barrier of Ge diffusion in $SiGe_{0.2}$ is reduced, making this diffusion path efficient. In this temperature regime, the Ge concentration is homogenized over the whole ($SiGe_{0.2}$ /$SiGe_{0.5}$/Si) structure. We demonstrate that the system is driven by the minimisation of the free energy of the system. Low concentration SSGOI layers are obtained in this regime.

Short CV

Isabelle Berbezier is senior researcher at the "Centre national de la recherche scientifique (CNRS)" in France. She gained considerable experience in Material Sciences and Matter Physics from the starting of her carrier at the car manufacturer Renault, where she was working on wear and friction in diesel engines for lubrication applications. She joined CNRS in 1987 and started to work on adhesion phenomena at the University of Lyon in collaboration with Aerospatiale. After one year in CNET Meylan devoted to high resolution transmission electron microscopy studies, she moved to Marseille, where she developed a new field of research on silicon-germanium. Her expertise encompasses the mechanisms of crystal growth and the self-organization of semiconductor nanostructures. Her activities are mainly devoted to the relation between the physical properties of nanostructures and their atomic structure. At present she works on Si-Ge-based nanomembranes, nanowires and nanocrystals. She is the author of more than 170 publications including reviews in international journals and chapters of books. She has given more than 180 international talks with 70 invited talks and several seminars in various institutes around the world. She has led or co-organised about 15 International Conferences. With Maurizio De Crescenzi, she created the International Conference on Nanostructures Self-Assembly (NanoSEA) in 2006.

Micro & Nano 2015