

Abstract : max 300 mots + 3 key words

For session S13: Experimental nanomechanics

Strain engineering of thin semiconductor films investigated using the residual-stress-actuated on-chip testing method

Marie-Stéphane Colla (1), Nicolas Roisin (2), Denis Flandre (2), Jean-Pierre Raskin (2), Thomas Pardoen (1, 3)

(1) Institute of Mechanics, Materials and Civil Engineering (IMMC), UCLouvain, B-1348, Louvain-la-Neuve, Belgium

(2) Institute of Information and Communication Technologies, Electronics and Applied Mathematics (ICTEAM), UCLouvain, B-1348, Louvain-la-Neuve, Belgium

(3) WEL Research Institute, avenue Pasteur, 6, 133 Wavre, Belgium

The versatile residual-stress-actuated on-chip tensile testing method has proven over the last years its potential for the characterization of the link between the mechanical behaviour and microstructure at the micro- and nanoscale. Recently, the on-chip method has appeared promising to tackle challenges related to strain engineering studies. Strain engineering studies refer essentially to the exploration of the evolution of functional properties under elastic distortions. Nano- and micro-scale specimens are particularly suited as they usually are stronger than macroscopic specimens and thus allow larger elastic strain without fracture. The difficulty is to impose well-defined mechanical conditions at small scale. Two practical examples are presented in this work.

First, experimental validation of theoretical band gap calculations (first-principles calculations based on density functional theory) is provided through photoluminescence spectroscopy measurements performed on on-chip microfabricated monocrystalline Si specimens deformed up to $\sim 1\%$ under uniaxial tensile stress.

Second, while uniaxial tension is highly relevant to determine several mechanical properties, the first-principles calculations have highlighted the interest of biaxial and shear loading configurations to improve more efficiently the band structure of silicon. On-chip shear and biaxial configurations have thus been designed. Experimental proof of concept of these new structures is provided on monocrystalline silicon.