State-of-the-art semiconductor characterisation in an aberration-corrected transmission electron microscope.

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ABSTRACT

In September 2005, CEA-LETI received the first FEI Probe Corrected Titan TEM that was delivered. In this presentation we will show how this state-of-the-art TEM has been successfully used to develop and apply new techniques in order to characterise the latest generations of nm-scale semiconductor devices.

We will critically discuss the advantages of having a probe corrector installed in our TEM and show examples of how it has been applied to diverse applications from the imaging of single dopants in quantum dots to STEM-EELS applied to high-k metal gates. In addition we will discuss how an ultra-stable modern TEM can be used to perform multiple techniques on the same TEM specimen, for example structural information by HAADF STEM, chemical mapping by STEM EELS and dopant and strain mapping by electron holography. Figure 1(a) shows a dopant map of a 40-nm gate n-MOS device with 1-nm-resolution acquired by electron holography. Figure 1(b) and (c) shows a TEM image and an in-plane strain map of a 27-nm recessed source and drain device. The strain profiles are shown in (d) and these are consistent with the strain profiles shown in (e) that were acquired from the same sample but by using Nanobeam Electron Diffraction (NBED).

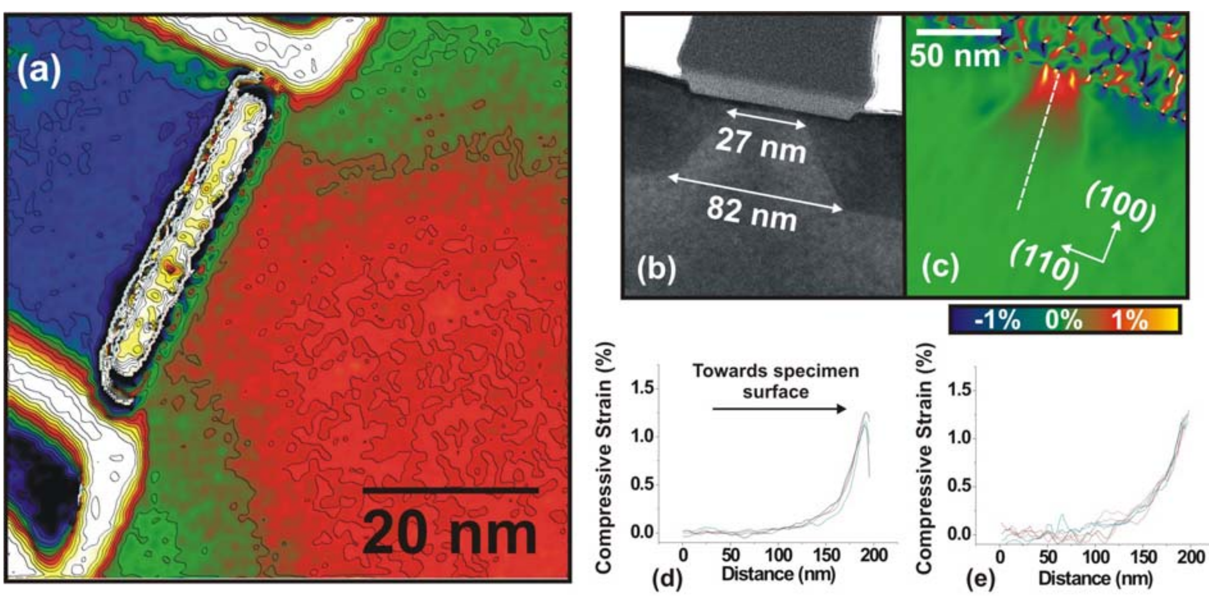

FIGURE 1. (a) Dopant map with 1 nm spatial resolution. (b) TEM image and (c) Strain Map of a 27 nm gate SiGe device. (d) and (e) show strain profiles that have been acquired by dark-field electron holography and NBED from the same sample.

Keywords: Transmission Electron Microscopy, Aberration Correction, Electron Holography

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