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Dislocations in Si-rich SiGe waveguides

At present, SiGe based electronic devices represent a small but relevant portion of the semiconductor market. It is also expected that the employment of SiGe alloys allows improvement of a variety of optical devices.

Lattice constant of germanium exceeds that of silicon by 4.2%.As a result $Si_{1-x}Ge_x$ layers grown on top of Si substrate are either pseudomorphically strained or relaxed with the formation of misfit dislocations at the interfaces, depending on the Ge content x and on the SiGe layer thickness[1]. Determining the onset of relaxation is not a trivial task because of the resolution limits of the most commonly used techniques. Thus a strain relaxation below 10^{-4} is not accessible to high resolution X-ray diffraction (XRD), while transmission electron microscopy (TEM), apart from being a destructive technique, is limited by the field of view. It seems therefore evident that finding a fast, non destructive characterization technique, with the sensitivity of X-ray topography, would be high desirable. In this project we propose an example of such a technique, in which the distortion of an optical wavefront gives a measure of the density of misfit dislocations and hence the degree of relaxation of a SiGe epilayer. The method is applicable to structures in which the light is tightly confined inside the SiGe layer under test. The light propagation inside SiGe can then easily be modeled in order to quantify the effect of dislocations. As test structures, we used Si/SiGe/Si planar samples grown by LEPECVD[2] technique, consisting of 2 μm thick SiGe layers, at various Ge concentrations (2%, 4%, 5%, 6%), covered by a 10 μm thick Si layer.

References

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