

High Frequency Acoustics For Probing At Nanometer Scale in SOI-based stacks

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As dimensions in devices continuously shrink, available tools have to be refined and novel schemes explored. Here we do show that high frequency acoustics provides interesting opportunities when dimensions come in the nm range. We present Raman-Brillouin scattering (R-BS) involving high frequency acoustic phonons from stacks based on SOI structures (i.e. a thin silicon layer separated from a silicon substrate by a buried oxide layer) having additional inserted or deposited SiO₂, Si₃N₄ or Al₂O₃ layers with thicknesses in the nm range. We have shown recently that thin Silicon On Insulator (SOI) layers can be used as internal probes, providing simultaneously the generation and detection of THz acoustic phonons [1] and avoiding the deposition of transducers (which are required in conventional optical pump-probe experiments). We demonstrate that the R-BS from the SOI layer is very sensitive to its environment, i.e. the other layers in the stack. As an example, Figure 1 shows how the SOI R-BS depends on the thickness of an Al₂O₃ capping layer.

Comparing experiment and simulations allows one to perform a quantitative analysis of the actual stack characteristics, regarding layer thicknesses, elastic properties and the presence of interfacial layers. Interestingly, high frequency acoustic phonons are particularly sensitive to the interface quality. The correlation between R-BS and Electron Energy Loss Spectroscopy is presented. We demonstrate that the R-BS from a ultra-thin SOI layer provides a means of probing properties of surrounding layers and materials at nm-scale.

Keywords : acoustic, phonon, SOI

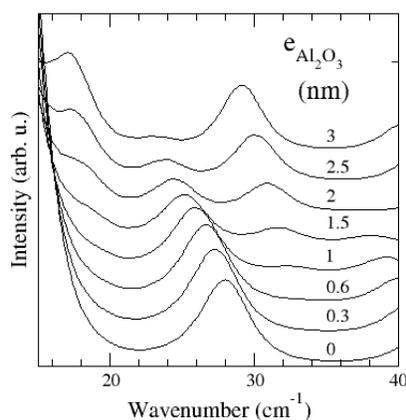


FIGURE 1. Calculated R-BS from a 20 nm thick SOI capped with Al₂O₃, as a function of cap layer thickness.

1. N. Lou, J. Groenen, G. Benassayag and A. Zwick, *Appl. Phys. Letters* **97**, 141908 (2010).
2. J. Groenen, F. Poinsette, A. Zwick, C. M. Sotomayor Torres, M. Prunilla and J. Ahopelto, *Phys. Rev.* **B 77**, 045420 (2008).