Thermal Conductivity of Ultra-Thin Silicon Nitride Films

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Context Since advances in integration density of ICs and MEMS have shrunk the dimensions of these devices, surface effects have became increasingly important. It has been shown that that energy transport in ultra-thin SiO2 films can be drastically enhanced by surface phonon polaritons (SPPs) [1]. Besides SiO2, silicon nitride is the most commonly used dielectric material in semiconductor technology, hence it is of great interest for thermal management of devices fabricated using that technology. Furthermore, the mechanical pre-stress in silicon nitride films can be tuned so that free-standing structures for thermal transport investigations can easily be fabricated.

Objectives & Methods Within this projects the excitation of SPPs in silicon-rich silicon nitride (SiN) films will be investigated by Fourier transform infrared spectroscopy (FTIR). Furthermore, methods for thermal conductivity measurements of ultra-thin SiN films are evaluated. Therefore, large free-standing membranes are fabricated and functional metal components are integrated on the membrane. This enables to apply well-known measurement techniques for the thermal conductivity [2,3] to these films.

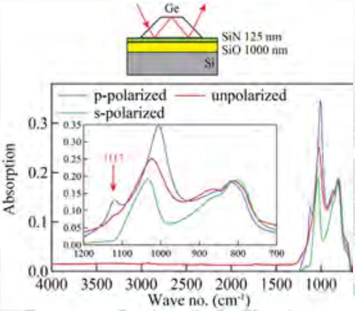

Fig. 1. FTIR adsorption spectrum (Kretschmann configuration) of a 125 nm

Results The adsorption spectra of SiN films were investigated under different boundary conditions. Adsorption peaks were identified which can possibly assigned to SPP excitation (Fig. 1). Furthermore, ultra-thin (125 nm) and large (2×2 cm2) SiN membranes were fabricated with metal components on top (Fig. 2). With these membranes thermal conductivity measurements were performed using the 3ω-technique [2].

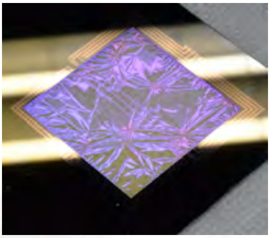

Fig. 2. 2×2 cm2 membrane device for the measurement of the thermal conductivity

References

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