

# Swelling and optical properties of Si<sub>3</sub>N<sub>4</sub> films irradiated in the electronic regime

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Thin layers of silicon nitride (Si<sub>3</sub>N<sub>4</sub>) are widely used in microelectronics, for instance as gate insulators [1] or as antireflection coatings for solar cells [2]. In this work we used low pressure chemical vapor deposition (LPCVD) to process stoichiometric Si<sub>3</sub>N<sub>4</sub> films of 140 nm thickness on silicon wafers. The samples were irradiated with either Pb ions of 110 MeV or Xe ions of 710 MeV delivered by the GANIL accelerator of Caen (France). As shown in a previous study [3] these irradiation conditions, characterized by a predominant electronic slowing-down ( $S_e \approx 20 \text{ keV.nm}^{-1}$ ), lead to damage creation and etchable tracks formation in Si<sub>3</sub>N<sub>4</sub>. In the present study we investigated other radiation-induced effects like out of plane swelling and refractive index decrease. From profilometry, step heights as large as 50 nm were evidenced for samples irradiated at the highest fluences ( $\approx 10^{13} \text{ cm}^{-2}$ ). From optical spectroscopy, the minimum reflectivity of the target is shifted towards the high wavelengths at increasing fluences. The reflectivity spectra were modeled in the framework of the Maxwell-Garnett theory, assuming a concomitant decrease of density and refractive index in irradiated Si<sub>3</sub>N<sub>4</sub>. Additional measurements, performed by ellipsometry, are in full agreement with this interpretation.

[1] M. Moslehi *et al.*, *Appl. Phys. Lett.* **47** (1985) 1113.

[2] A.G. Aberle, *Sol. Energy Mater. Sol. Cells.* **65** (2001) 239.

[3] B. Canut *et al.*, *to be published in Nucl. Instr. and Meth.* **B** (2008).