

# Young's Modulus and Residual Stress of LPCVD Silicon-Rich Silicon Nitride Determined from Membrane Deflection

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A particularly simple experimental setup is described for determining residual stress and Young's modulus by a membrane deflection technique. Details of the measurement technique and the method for extracting the afore-mentioned mechanical properties from membrane deflection measurements are presented. Comparison of membrane deflection measurements with wafer curvature measurements shows that for low-pressure chemical-vapor-deposited (LPCVD) films of silicon-rich silicon nitride ( $\text{Si}_x\text{N}_y$ ), the stress obtained by the latter method is consistently 2-3 times higher than by the former method. An extensive set of measurements of residual stress and Young's modulus values are presented for  $\text{Si}_x\text{N}_y$  membranes, including as-deposited silicon nitride and silicon nitride membranes subjected to low-temperature oxidation, densification, high-temperature heat treatments, and the addition of a ZnO layer.

## 1. Introduction

Interest in the mechanical properties of thin films has increased greatly with the development of microelectro-mechanical systems (MEMS).<sup>(1-4)</sup> One property of thin films that is of particular interest is the residual stress. The most commonly employed method for measuring residual stress is the wafer curvature technique.<sup>(5)</sup>