Elemental quantification of carbon nanotube (CNT) pellicles for EUV lithography application

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High-volume chip manufacturing using extreme ultraviolet (EUV) lithography requires protecting the photolithography mask from fall-on particles [1]. A proven solution is to position a free-standing carbon nanotube (CNT) pellicle a few millimeters in front of the reflective photomask to capture stray particles while keeping them out of focus and preserving EUV transmission above 90% [2]. The composition, density, and bundle size of CNTs are being tuned to optimally withstand the harsh operating environment within the EUV scanner [3]. However, achieving the suitable CNT pellicle requires accurate characterization, presenting a significant metrology challenge due to the nanometric thickness of these membranes.

In this work, we demonstrate that Rutherford backscattering spectrometry (RBS) enables the accurate elemental quantification of CNT pellicles, which includes light elements such as B, C and N. Furthermore, we demonstrate that the areal densities determined with RBS can be used to estimate the EUV transmission at λ = 13.5 nm. Our analysis reveals a good agreement between the calculated EUV transmission based on RBS and the directly measured EUV transmissivity. The calculation of the EUV transmission based on RBS analyses provides unique insights into elemental-specific EUV absorption, establishing it as a valuable tool for advancing CNT pellicle developments for the EUV lithography technology.

Reference

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