Renewable single-walled carbon nanotube membranes for extreme ultraviolet pellicle applications

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We propose a facile, cost-efficient, environmentally friendly, and scalable process to renew single-walled carbon nanotube membranes serving as extreme ultraviolet (EUV) protective pellicles. The method comprises of high-temperature treatment of the membrane by Joule (resistive) heating at temperatures higher than 1000 ◦C and pressure below 0.3 Pa. Using model Sn aerosol nanoparticles, the primary contaminant from extreme ultraviolet light sources, we demonstrate the proposed method to clean the membrane with the power consumption as low as 20 W/cm2. We show the proposed method to cause no harm to carbon nanotube structure, opening a route towards multiple membrane renovation. We confirm the applicability of the approach using in situ deposition from the semi-industrial EUV light source and subsequent Sn-based contaminant removal, which restores the EUV-UV-vis-NIR transmittance of the film and, therefore, the light source performance. The proposed method supports pulse-cycling opening an avenue for enhanced protection of the lithography mask and stable perfor-mance of the EUV light source. Additionally, the approach suits other composite contaminants based on such species as Pb, In, Sb, etc. This work was partially supported by the Council on grants (project for young scientists number МК-3000.2022.1.3)