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**Fabrication of thin diamond membranes for quantum information processing** IGOR AHARONOVICH, JONATHAN LEE, ANDREW MAGYAR, EVELYN HU, Harvard University — Coupling of nano-photonic devices to color centers in diamond offers exceptional opportunities to enhance our understanding of light-matter interactions. The formation of thin single crystal diamond membranes containing such centers, is an important prerequisite for the fabrication of diamond based devices. However, there are challenges in forming such membranes in ways that do not compromise the quality of the cavities or the optical properties of the emitters. Here we report the formation of optically active diamond membranes and the subsequent fabrication of optical cavities. In our approach, 1.7 $\mu$m thick diamond membranes were generated by forming a sacrificial layer using ion implantation, followed by thermal annealing. These membranes then served as templates for the epitaxial overgrowth of $\sim$ 300 nm of diamond using CVD. Remarkably, the regrown films reveal the presence of optically active defects which were *not* present in the template, such as silicon-vacancy (SiV) or nitrogen vacancy centers. Microdisk cavities were then formed from the regrown single crystal diamond membranes. Whispering gallery modes (WGMs) with quality factors of $\sim$ 3000 were measured from the diamond cavities. Spectral overlap of WGMs with the zero phonon line of SiV centers was observed and lifetime reduction of the coupled emitter – cavity system was measured. The demonstration of coupling between diamond emitters and a single crystal diamond cavity is a crucial step towards diamond integrated nano-photonic networks.

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