

# Fabrication of Directly Bonded Diamond Membrane Heterostructures

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## 1. Introduction

Single-crystal diamond membranes offer numerous opportunities for future quantum technologies. However, improving our abilities to integrate these membranes in heterogeneous structures is essential in realizing their potential. In our work, we present processes to prepare and ultimately direct bond diamond membranes to various substrates including fused silica, thermal oxide, sapphire, and lithium niobate. We have three main processes – a transfer process, a surface preparation process, and a bonding process – each of which are optimized to maximize yield, scalability, and quality. While our transfer process minimizes contamination and maximizes yield, our preparation process allows for tunable membrane thicknesses ranging from 10nm to 440nm. Our bonding process combines our transfer process with surface functionalization and annealing and results in durable diamond membrane heterostructures.