Optimization and characterization of the release process of thin diamond membranes in the fabrication of diamond nanophotonic circuits

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Group Meeting Presentation:	*Project midpoint*		

Context: Diamond-based photonic integrated circuits (PICs) are a new and exciting field of photonics technology that utilize diamond to fabricate integrated circuits for photonic applications. Diamond can host colour centres, impurities introduced in the crystal lattice, that create additional electronic states in the wide band gap of diamond, giving rise to transitions that absorb and emit light in the visible spectrum. This makes diamond ideal for applications in **quantum sensing, imaging and computing**. The wide bandgap of diamond crystals also makes diamond an ideal material for photonic applications in a wide range of wavelengths, from the UV to the infrared. The development of diamond-based PICs is an ongoing research area, and new advances in materials, fabrication methods, and device designs are expected to further enhance their performance and versatility.

Project overview: The fabrication methods used to create diamond-based PICs are crucial in determining their performance and capabilities. Currently, two main methods are used: epitaxial growth and hybrid integration. At LQNO, we are focused on hybrid integration which involves bonding a thin diamond membrane to a conventional silicon substrate. The fabrication, release, and manipulation of the membrane represents a big challenge, and the **goal of the project is to characterize and optimize the release process of the membrane, enabled by electrochemical etching.**

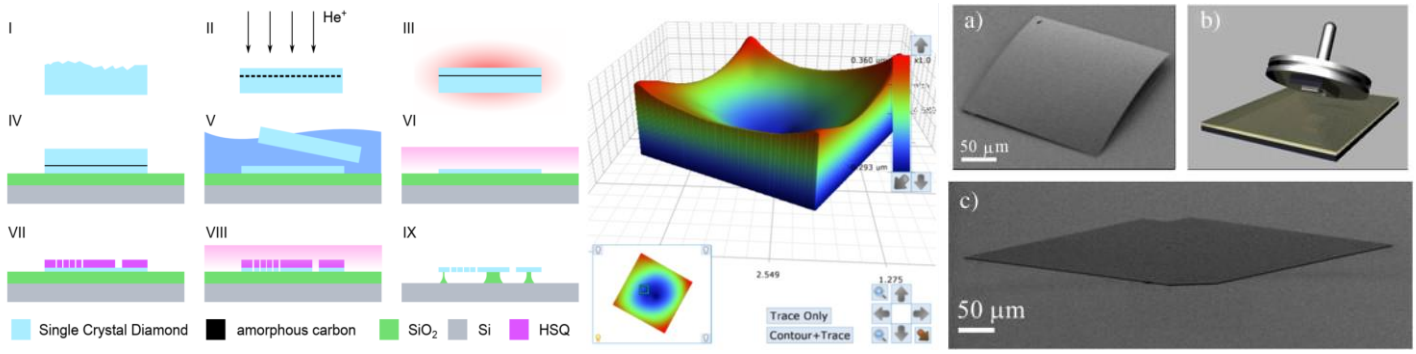

Figure 1. *Left: Membrane fabrication scheme [1]. Center: Profilometry of own membranes. Right: Diamond micro-membranes [2].*

What the student will do: The student will take part in the cleanroom microfabrication work, by **operating a custom made electrochemical etching setup, optimizing the setup, and characterizing the etching dynamics** in the context of an industrializable implementation of the fabrication of thin diamond membranes.

All these studies will rely on **quantitative and qualitative metrological studies** in the cleanroom (SEM, AFM, optical microscopy, profilometer, etc.).

Student gain: Through this project, the student will gain a vast hands-on experience in the handling of clean-room techniques such as wet etching, and electrochemical etching, and the use of industry standard metrology tools. The student will understand the challenges in hybrid integration of photonic structures, and use their knowledge to optimize one of the most promising techniques in the topic of integrated diamond photonic structures.

[1] M. Kiss, Advanced Diamond Microfabrication for Microoptics and Photonics, Lausanne, EPFL, 2019, https://doi.org/10.5075/epfl-thesis-9771
[2] J C. Lee, A. P. Magyar, D. O. Bracher, I. Aharonovich, E. L. Hu, Fabrication of thin diamond membranes for photonic applications, Diamond and Related Materials, Volume 33, 2013, Pages 45-48, ISSN 0925-9635, https://doi.org/10.1016/j.diamond.2012.12.008