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Opportunity

To accelerate the development and validation of the single crystal diamond membranes through licensing and/or co-development, contact:

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Fabrication of single crystal diamond membranes

Producing high-quality ultra-thin membranes for integrated photonics

The technology

- The scalable method produces high-quality ultra-thin single crystal diamond membranes. They are suitable for a wide range of applications in optics, sensing, quantum computing and filtration and for use as high-strength, ultra-thin vacuum windows.

Market need

- Industrially scalable fabrication methods are needed to exploit the superior chemical, physical and structural properties of single crystal diamond for use in integrated photonics.

Technology status

- The method produces thin (<300 nm) large-area, single crystal diamond membranes at up to half the cost of current techniques.

Market need

The use of diamond in advanced engineering applications has been limited by the high cost and inconsistent properties of natural diamond and the difficulties in creating high-quality synthetic diamond.

Methods such as milling, ion implantation, diamond-on-insulator and quartz clamping can be used to fabricate thin diamond sheets, or membranes. Although diamond membranes as thin as 200 nm have been made, they typically lack the optical, structural and surface qualities necessary for many applications. In addition, the methods are not easily scalable or robust, and they often have low yield.

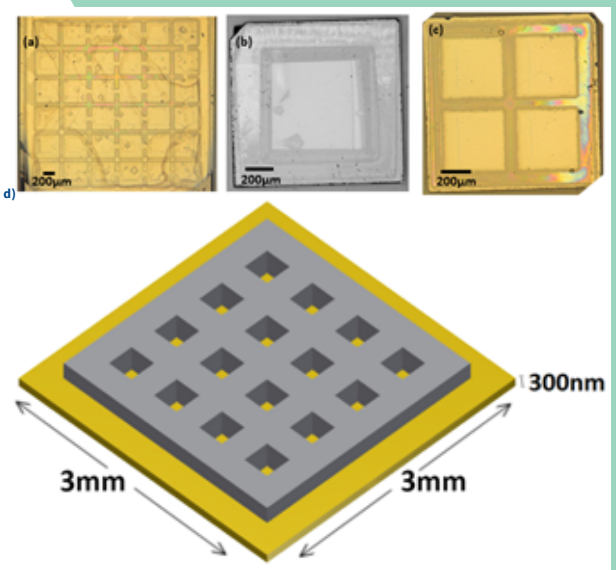
Diamond is one of the hardest, stiffest, strongest and most thermally conductive, chemically inert and optically transparent materials. These properties are optimal in single crystal diamond. It has great potential in many applications, from integrated photonics and laser technology to remote sensing and quantum computing. It can also be used in vacuum chambers, which need a transparent window that can withstand high pressures.

Solution

A commercially viable method for fabricating ultra-thin membranes from single crystal diamond has been developed by researchers at the University of Melbourne.

The method combines a proprietary technique with microwave plasma chemical vapour deposition to grow high-quality membranes on an ion-implanted substrate. The membrane thickness is reduced through reactive ion etching.

The method overcomes the limitations of current techniques. It reliably and consistently produces structurally robust membranes with thicknesses of <300 nm, uniform to within 50 nm over a 2–3 mm2 area.



Picture: Optical images of single crystal diamond, a) 6x6 window, b) 1x1 window, and 2x2 window and d) a CAD drawing of the ultra-thin windows.

Technology and IP status

The method yields single crystal diamond (Raman FWHM = 2.1 cm-1) of high surface quality (RMS = 2–3 nm) at approximately 25–50 per cent of the cost of existing techniques. The membranes are electronic grade with boron and nitrogen impurities of less than 10 ppb.

The membranes are bonded to a diamond scaffold that provides mechanical stability and ease of handling (for subsequent steps such as implantation, annealing and chemical etching). The membranes can also be transferred to a customer's chosen substrate.

The membranes and their method of fabrication are the subject of a patent application. Further research and development is underway to explore new applications of the technology.

Tech name and number:	**2014-035** High-quality Ultrathin Single Crystal Diamond Membranes
Researchers:	Professor Steven Prawer, Dr Afaq Piracha and colleagues
Publications:	A.H. Piracha, K. Ganesan, D. W. M. Lau, A. Stacey, L. P. McGuinness, S. Tomljenovic-Hanic, S. Prawer, Scalable fabrication of high-quality, ultra-thin single crystal diamond membrane windows, Nanoscale, 2016, 8, 6860-6865, DOI: 10.1039/C5NR08348F
Patents:	PCT/AU2015/000625, filed on 15. October 2015
Keywords:	Single crystal diamond windows, optics, reduced optical losses

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