Synthesis of polycrystalline diamond membranes and their material properties

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Polycrystalline diamond has excellent material properties such as high carrier mobility, excellent thermal and mechanical properties. Although polycrystalline diamond has been widely used as a surface protection layer, its practical use in electronic applications has been limited due to unfavorable synthesis conditions, such as the formation of low quality nucleation layers and the introduction of thermal stress during growth. Polycrystalline diamond (PCD) membrane is a different format of polycrystalline diamond film that is a free-standing form. The PCD membrane is also a transferable diamond film that has a wide range of freedom in their thicknesses (a few tens of nm to hundreds of microns), size (micron-size to a full wafer scale), doping type/concentration. Therefore, PCD membranes can be heterogeneously integrated with other foreign substrates or platforms, simply by means of micro transfer printing, which is an established semiconductor fabrication technique.

In this talk, I will primarily focus on the synthesis process of PCD membranes and their manipulation method. Basic material properties of PCD membranes, which make them suitable for use in electronic devices, will be presented. Then, I will discuss electrical properties of PCD membrane-based Schottky diodes. Finally, I will discuss the future perspectives of PCD membranes in various novel applications, including 3D-stackable electronics, highly reliable bioelectronics, less-corrosive electrodes, heat dissipators, and flexible electronics.