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Fabrication and electrical characterization of three-dimensional graphitic microchannels in single crystal diamond

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Abstract. We report on the systematic characterization of conductive micro-channels fabricated in single-crystal diamond with direct ion microbeam writing. Focused high-energy (∼MeV) helium ions are employed to selectively convert diamond with micrometric spatial accuracy to a stable graphitic phase upon thermal annealing, due to the induced structural damage occurring at the end-of-range. A variable-thickness mask allows the accurate modulation of the depth at which the microchannels are formed, from several μm deep up to the very surface of the sample. By means of cross-sectional transmission electron microscopy (TEM), we demonstrate that the technique allows the direct writing of amorphous (and graphitic, upon suitable thermal annealing) microstructures extending within the insulating diamond matrix in the three spatial directions, and in particular, that buried channels embedded in a highly insulating matrix emerge and electrically connect to the sample surface at specific locations. Moreover, by means of electrical characterization at both

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