Creation of colour centres in diamond by collimated ion-implantation through nano-channels in mica

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The fabrication of scalable quantum devices in diamond relies on the ability to produce optical centres with a high spatial resolution. Ion implantation is the most powerful technique for placing impurity atoms in a diamond matrix. Even though shallow optical centres can be produced with a resolution below 20 nm, deep centres may be preferred for generally better verall properties. However, the focusing of ion beams in the MeV range can hardly be achieved below 1mm. We present here a novel approach by implanting ions through a mask with high-aspect-ratio nano-channels and improve the collimation to below 50 nm. The mask contains parallel oriented channels of a few tens of nanometres in diameter. They are produced by exposing mica sheets to GeV heavy ion projectiles and subsequent track etching. We demonstrate the high-resolution creation of deep nitrogen-vacancy (NV) centres in diamond by implanting nitrogen ions through the nano-channels. Transmission rates and energy distribution of the nitrogen ions transmitted through the nano-channels were also analysed.