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Pulsed laser fabrication of 3D diamond sensors

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3D detectors whose electrodes extend perpendicularly to the sensor surface are one of the solution proposed for the challenges of radiation-harsh environments in high energy physics.
We report on the fabrication and characterization of prototypes of 3D diamond sensors, which add to the 3D architecture the advantages of diamond as a sensor for tracking purposes.
Two different laser sources, a Nd:YAG 1064 nm Q-switched laser with an 8 ns pulse-width and a Ti:Sa 800 nm laser source with a 30 fs pulse duration were used to create arrays of graphitic columns in the bulk of polycrystalline and single crystal diamond samples. The columns are staggered and connected to graphitic combs which have been fabricated as well by laser irradiation, used for bias contact and readout. On each sample an identical pattern of graphitic combs, without columns (2D structure) has been also fabricated as a reference. The charge collection efficiency of each 3D sensor has been measured at different voltages and compared with that of the corresponding 2D structures. The much lower saturation voltage of the 3D sensors in comparison with the planar ones confirm that charge collection takes place at the columnar electrodes, but a lost in efficiency up to 30% is observed, depending on the laser source used and on the substrate. Possible reasons of the lost of efficiency are discussed.

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