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Performance evaluation of different diamond-like carbon samples as charge state conversion surfaces for neutral atom imaging detectors in space applications

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The detection of energetic neutral atoms is a substantial requirement on every space mission mapping particle populations of a planetary magnetosphere or plasma of the interstellar medium. For imaging neutrals, these first have to be ionised. Regarding the constraints of weight, volume and power consumption, the technique of surface ionisation complies with all specifications of a space mission. Particularly low energy neutral atoms, which cannot be ionised by passing through a foil, are ionised by scattering on a charge state conversion surface [1].
Since more than 30 years intense research work is done to find and optimise suitable materials for use as charge state conversion surfaces for space application. Crucial parameters are the ionisation efficiency of the surface material and the scattering properties. Regarding these parameters, diamond-like carbon was proven advantageously: While efficiently ionising incoming neutral atoms, diamond stands out by its durability and chemical inertness [2]. In the IBEX-Lo sensor, a diamond-like carbon surface is used for ionisation of neutral atoms. Building on the successes of the IBEX mission [3], the follow up mission IMAP (InterstellarMApping Probe) will take up to further explore the boundaries of the heliosphere. The IMAP mission is planned to map neutral atoms in a larger energy range and with a distinct better angular resolution and sensitivity than IBEX [4]. The aspired performance of the IMAP sensors implies also for charge state conversion surfaces with improved characteristics. We investigated samples of diamond-like carbon, manufactured by the chemical vapour deposition (CVD) method, regarding their ionisation efficiency, scattering and reflexion properties. Experiments were carried out at the ILENA facility at the University of Bern [5] with hydrogen and oxygen atoms, which are the species of main interest in magnetospheric research [1]. We compare the results of earlier investigations of a metallised CVD sample [6] to our latest measurements of a Boron-doped CVD diamond sample. We additionally measured the B-concentration in the sample to prove our predictions of the B-concentration needed to reach sufficient conductibility for the sample not getting electrostatically charged during instrument operation. The results of narrower scattering cones and higher ionisation efficiency show that diamond-like carbon still is the preferred material for charge state conversion surfaces and that new surface technologies offer improved diamond conversion surfaces with different properties and hence the possibility for improvement of the performance of neutral atom imaging instruments.

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