3D ion microscopy of hydrogen in diamond

P. Reichart[1,2], G. Dollinger[1], A. Hauptner[1] and C. Wild[3]

[1]*Physik Department E12, TU München,85748 Garching, Germany*
[2]*Microanalytical Research Centre, School of Physics, University of Melbourne, Victoria 3010, Australia*
[3]*Frauenhofer IAF, 79108 Freiburg, Germany*

CVD grown diamond films contain small amounts of hydrogen. The question whether and how much hydrogen is located at grain boundaries or other structural defects was unsolved up to now in spite of a long history of investigation. With our setup for 3D hydrogen microscopy at the Munich microprobe SNAKE (Superconducting Nanoprobe for Applied nuclear (Kern-) physics Experiments) [1] we were able to clear this question without doubt. Imaging a <110> textured layer with 17 MeV protons and a lateral resolution of 0.6 µm we detected an enhancement of hydrogen localized at the grain boundaries with an average content of $8.1 \cdot 10^{14}$ at/cm^2 at the grain interfaces. Inside the grains the hydrogen content was found to be below the detection limit of 0.08 at-ppm.

These results are used to demonstrate the potential of the applied coincident elastic proton proton scattering technique [2], which is the only ion beam analysis method with low enough damage potential to perform sensitive hydrogen imaging at microscopic beam dimensions [3]. The sub-ppm sensitivity at SNAKE is achieved with a segmented annular detector covering a 2.3 sr solid angle of detection together with a 5-level coincidence filtering providing a 2 ns time resolution. It provides sufficient suppression of accidental coincidences even at count rates up to 100 kHz [4].

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