# 3D-Hydrogen Microscopy

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Nearly any material contains hydrogen in more or less quantities. In spite of its importance to materials properties, microscopic hydrogen distributions are not easy to be analysed by standard techniques for elemental imaging. It has been demonstrated recently that proton-proton (pp-) scattering performed at proton microprobes may fill the gap and can serve as an ideal tool for hydrogen microscopy in two or even three dimensions. pp-scattering is based on the coincident detection of the two protons which are emitted from a proton of the beam scattered at a hydrogen atom in the target. It allows a background free detection of hydrogen at a sensitivity level which is better than at-ppm when using sophisticated multi-strip silicon detectors. Important is the low damage potential of pp-scattering compared to all other ion beam methods for hydrogen analysis and, thus, it can be utilised at proton microprobes.

The pp-scattering technique has already been applied by several groups on standard proton microprobes using proton energies of 3 MeV. We have demonstrated, that higher proton energies (4 – 28 MeV) as they are available at the microprobe SNAKE (Superconducting Nanoscope for Applied nuclear (Kern-) physics Experiments) at the Munich 14 MV tandem accelerator may be advantageous for a widespread use in materials research. The higher proton energies enable us to analyse thicker samples (up to 100 µm or even more) and thus we have only minor needs in target preparation. The power of 3D-hydrogen microscopy is demonstrated by analysing the wing of a mayfly (fig.1) [1] and the spatial resolved detection of trace amounts of hydrogen in CVD diamond [2].

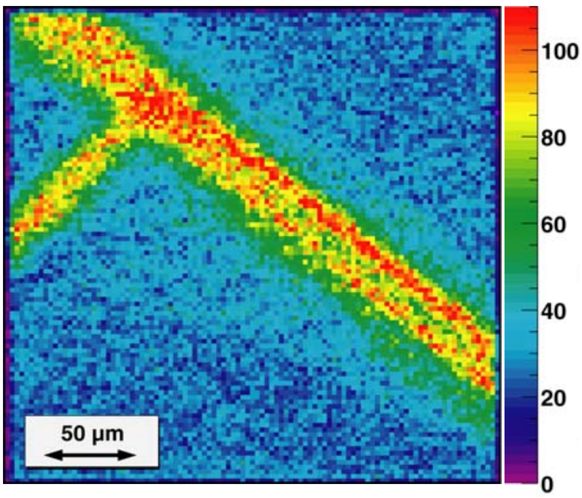


Fig. 1:
2D-hydrogen distribution of the wing of a mayfly showing the interconnect of two capillaries. From the hydrogen distribution at the wider capillary it can be deduced, that the capillary is hollow and not filled with water when the wing was analysed.

[1] G. Dollinger, P. Reichart, G. Datzmann, A. Hauptner, H.-J. Körner, Appl. Phys. Lett. 82 (2003) 148.

[2] P. Reichart, G. Datzmann, A. Hauptner, R. Hertenberger, C. Wild, and G. Dollinger *Science* 306 (2004) 1537-1540.