European XFEL Workshop

Opportunities for microfluidic devices at Free-Electron Lasers

Rapid Mixing Microfluidics for Time-Resolved X-ray Scattering

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Microfluidics in combination with microbeam X-ray scattering is currently being developed into a powerful experimental methodology suitable for the time-resolved investigation of nanostructures, particle alignment and serial protein crystallography at synchrotrons and X-ray Free Electron Lasers (XFELs). This experimental approach enables the in situ study of kinetics with nano- or atomistic resolution by using X-ray compatible microflow chips and rapid mixing microfluidic liquid jet devices [1-6]. We present lithography-based microfluidic devices (see Fig.1B) that produce liquid jets with µm-diameters (0.9 to 5 µm) at very low flow rates (150 to 1000 µl h^{-1}) under atmospheric or vacuum conditions [5]. This microfluidic liquid jet system with highly reproducible geometries is based on the gas dynamic virtual nozzle (GDVN) design suitable for structural biology at serial femtosecond X-ray nanocrystallography [6] as well as time-resolved rapid mixing experiments with mixing times within tens of microseconds and a very defined time-zero point [3,5].

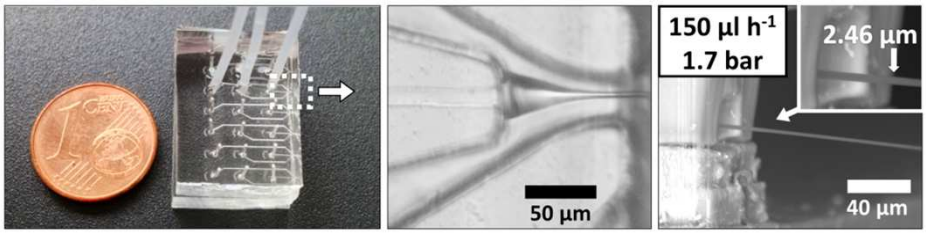

Figure 1 Microfluidic liquid jet device in operation [5].

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