Fixed-Targets for Serial Protein Crystallography at SwissFEL

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X-ray free electron lasers (XFELs) have enabled the overcoming of limitations of classical crystallography by outrunning radiation damage with their highly coherent and brilliant femtosecond pulses. As a consequence of crystal destruction, large numbers of new crystals must be introduced sequentially to the beam, establishing methods such as serial femtosecond crystallography (SFX) and time-resolved serial femtosecond crystallography (TR-SFX) [1]. Both SFX and TR-SFX have provided new modes of structural biology. However, the constant need to refresh crystals in the beam path is a constant challenge and improvements to sample delivery can greatly improve experimental outcomes.

Fixed-target sample delivery methods allow for a reduction of sample consumption and optimization of sample density without issues such as clogging. Fixed-targets also lend themselves to high throughput technologies and an increased ability to locate and position crystals. Silicon wafers are the most common fixed-target and offer an inert support for the immobilized crystals and a precise aperture array for rapid alignment strategies [2]. However, the silicon wafers are brittle, expensive and can give strong Si(111) reflections in misaligned [3, 4].

Here we present preliminary data on the fabrication of polymer-based fixed-targets being developed for TR-SFX at SwissMX, the new end station dedicated to fixed-target SFX at SwissFEL, Switzerland's X-ray free-electron laser. The polymer-based film provides low x-ray absorption and scattering background, high design flexibility and the potential mass-fabrication at low cost. Using silicon microfabrication and polymer replication technologies, we have designed inverted pyramidal shaped wells in membranes ranging from 25-50 µm in thickness. This design enables single crystals to funnel into predefined positions, optimizing the hit-rate of the probing X-ray beam.

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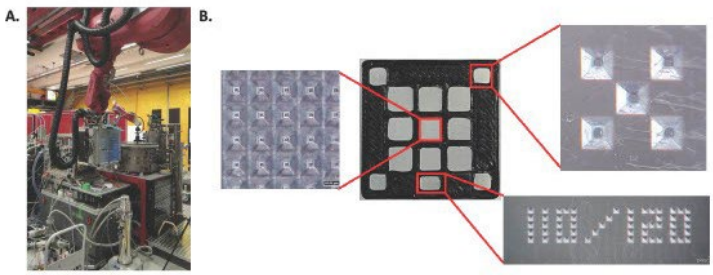

Figure 1. A. Fixed target endstation at SwissFEL B. First-generation polymer-based SwissMX fixed target composed of inverted pyramidal membrane, fiducials and a labeling system.