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Two-Photon Laser Lithography for Fabrication of XFEL Sample Injectors

X-ray Free Electron Lasers (XFEL) are a valuable tool for determining the structure of biological macromolecules. Obtaining accurate results necessitates solvation of the sample in a specified chemical solution throughout the injection process. This solvation must not unduly compromise the vacuum environment or cleanliness of the XFEL scattering chamber. Sample injection via liquid free streams has proven to be the only realistic means of satisfying both the biological and mechanical constraints. It is crucial to maintain vacuum compatibility and maximize x-ray scattering background. Meeting these requirements necessitates that the liquid free stream be no more than a few micrometers in diameter. Gas Dynamic Virtual Nozzles (GDVN) are able to deliver liquid free streams of 1 to 5 ?m diameter while largely avoiding the clogging difficulties that preclude injection with a simple solid-walled convergent nozzle. Unfortunately, GDVN devices are currently assembled entirely by hand, an expensive and time-consuming process.

Researchers at Arizona State University have invented a method of manufacturing GDVN using two-photon laser lithography. By appropriately tailoring the intensity and duration of the laser pulse, sub- micron resolution becomes relatively routine, and feature sizes as small as 50 nm have been reported. Moreover, it is a true 3D fabrication technique, capable of "writing" any desired voxel within a specified 3D volume. Standard 3D fabrication techniques complete projects by building structures one layer at a time, requiring the motors to constantly switch between mechanisms. This invention uses fast writing mechanisms to form each block separately, minimizing mechanical switches and production time.

Potential Applications

- X-ray Free Electron Lasers
- Nozzle manufacture
- Determination of biological structures
- Liquid free stream delivery

Benefits and Advantages

- Accuracy –
  - Solvated biological samples injected as a microscopic liquid stream into an analytical apparatus.
  - Mixing of solvated biological reagents on microsecond time scales.
  - Minimizes interaction of liquids and gases with lower-resolution, potentially permeable interfaces between units.
- Speed – Fast writing mechanisms employed to minimize mechanical switching of motors.

For more information about the inventor(s) and their research, please see

Dr. Bruce Doak's directory webpage