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Computational Three-Dimensional Imaging with the Near Infrared Synchrotron Beam Using Fresnel Zone Apertures Fabricated on Barium Fluoride Windows Using Femtosecond Laser Ablation

The infrared synchrotron beam has a unique fork shaped intensity distribution with a spectrum ranging from near infrared (~1 μm) to far infrared (~ 13 μm). All of the spectroscopy and molecular fingerprinting measurements are carried out in the mid to far infrared (NIR) region. Further, the presence of NIR beam reduces the signal to noise ratio by nearly four times. Consequently, a high pass (wavelength) filter is introduced at the entrance of the infrared microspectroscopy unit to block the NIR part. In this study, we have used the usually discarded NIR part of the synchrotron beam for three-dimensional imaging. Two Fresnel zone apertures were fabricated on barium fluoride windows with a thickness of ~1 mm using femtosecond ablation with a wavelength of 1030 nm, attenuator at 9%, 4 pulses per pixel and 3 pulses per step. The objective was a 0.26 NA objective which created a spot size of 4.8 um. The near infrared synchrotron beam was extracted from microspectroscopy unit. A pinhole was inserted in the path of the beam and the point spread function (PSF) was recorded using an image sensor sensitive to NIR. An object was mounted in the location of the pinhole and a second intensity distribution was recorded. The image of the object was reconstructed using computational processing of the PSF and the object intensity distribution. In a direct imaging system, a Fresnel zone aperture is required to be free of aberrations. In indirect imaging, the aberrations and fabrication errors present in the form of scattering improved the autocorrelation function. The preliminary results are promising.

Level of Expertise

Experience Researcher

Presenter Gender

Man

Pronouns

He/Him

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