# Phase Retrieval from a Sequence of Diffraction Patterns in Terahertz Regime

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Terahertz (THz) radiation, having the spectral range between microwaves and infrared (0.1-10 THz), has emerged as a powerful tool for spectroscopy and imaging due to its unique properties [1]. Imaging with THz pulse that utilizes THz time-domain spectroscopy (TDS) has an excellent capability of generating hyperspectral images that contain both the amplitude and phase information. On the other hand, CW THz sources having comparatively high power along with THz cameras and micro bolometric arrays can be used for rapid and efficient imaging.

In this study inspired from optics [2], we experimentally showcase the phase retrieval process from a sequence of recorded intensity patterns by coherent Terahertz diffractive imaging technique. The experimental setup as shown in Fig. 1(a) employs a 3.5 THz quantum cascade laser (QCL) emitting a collimated ~7 mm beam, which is directed onto a polypropylene (PP) 'Arrow' object and the resulting intensity-based diffraction pattern is captured using INO's MICROXCAM-384i THz camera, featuring a 388 ×288 pixels matrix with a 35 μm pitch. Initially, the object-to-camera distance is set at 6.5 mm. The camera (without the objective) mounted on a translation stage, is then moved axially in 0.2 mm increments, recording corresponding diffraction patterns. Positioning the object closer to the detector to capture higher-order frequencies introduces infrared thermal noise originating from the surroundings and the object itself which affects the recorded diffraction patterns. To mitigate this, background removal approach is used. A postprocessed diffraction pattern is as shown in Fig. 1(b). These postprocessed diffraction patterns are then used to retrieve the object's phase using the single-beam multiple-intensity phase retrieval algorithm with 50 iterations as shown in Fig. 1(c), incorporating Gaussian apodization to enhance the quality of the reconstructed phase image. The extracted profile on the phase image yielding an estimated sample thickness of 5.3 mm as shown in Fig. 1(d).

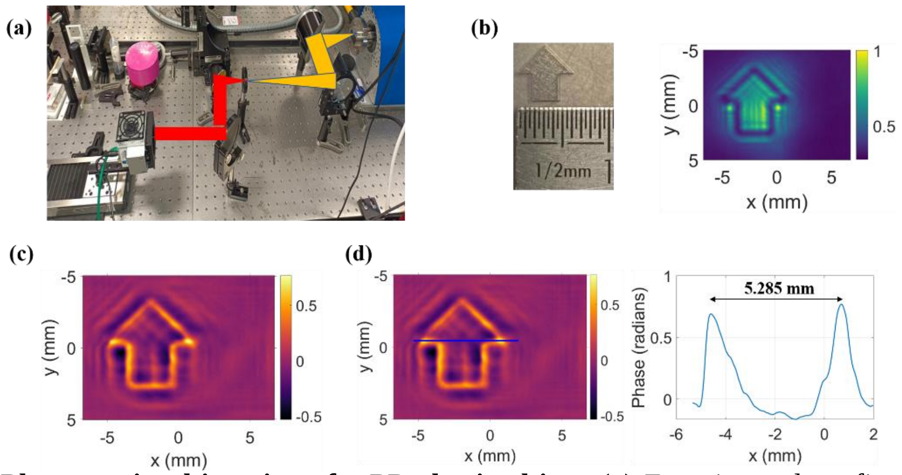


**Fig. 1 Phase retrieval imaging of a PP plastic object. (a)** Experimental configuration. **(b)** Optical image of the sample (left) and the postprocessed diffraction pattern at Plane 1 (right) respectively. **(c)** Reconstructed phase image. **(d)** Region of interest to plot the line profile on phase image (left) and the line profile plot (right) respectively.

## References

[1] O.A. Smolyanskaya, et al, "Terahertz biophotonics as a tool for studies of dielectric and spectral properties of biological tissues and liquids," Progress in Quantum Electronics **62**, 1-77 (2018).

[2] A. Chopard, E. Tsiplakova, N. Balbekin, O. Smolyanskaya, J-P. Perraud, J-P. Guillet, N. V. Petrov, P. Mounaix, "Single-scan multiplane phase retrieval with a radiation of terahertz quantum cascade laser," Applied Physics B **128**, 63 (2022).