3D Printed nozzle for a flat liquid jet for THz spectroscopy

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ABSTRACT

Field-resolved terahertz (THz) spectroscopy in the liquid phase is often fundamentally limited by the parasitic effects of sample containers. Standard windows introduce significant absorption, dispersion, and birefringence, while potentially triggering nonlinear responses that obscure the intrinsic dynamics of the analyte. To overcome these constraints, we present a method for field-resolved THz spectroscopy using windowless liquid sheets generated by a custom-designed, 3D-printed nozzle illustrated in Figure 1a.

The use of 3D printed nozzle designs gives the advantage of a fixed geometry, which significantly reduces the mechanical degrees of freedom and therefore simplifies the alignment. Furthermore, 3D printing provides a versatile and rapid prototyping platform to optimize fluidic geometries for various solvents. Our nozzle was specifically engineered to produce stable liquid sheets with a target thickness of 100µm; experimental characterization demonstrates the production of sheets in the range of 89.9µm for saturated sugar solutions, measured by Fabry Perot oscillations displayed in Figure 1b. By directly measuring the electric field, this windowless approach enables a precise normalization of the THz signal, depicted in Figure 1c, relative to the sheet thickness and solution concentration. This development provides a robust framework for high-sensitivity THz measurements of liquids, free from the artifacts typically associated with solid-state interfaces A photograph of the flat liquid sheet is captured in Figure 1d.
While flat liquid sheets have been used for water to do THz Spectroscopy [1], we are aming to use it for different bio samples like saturated sugar solutions.

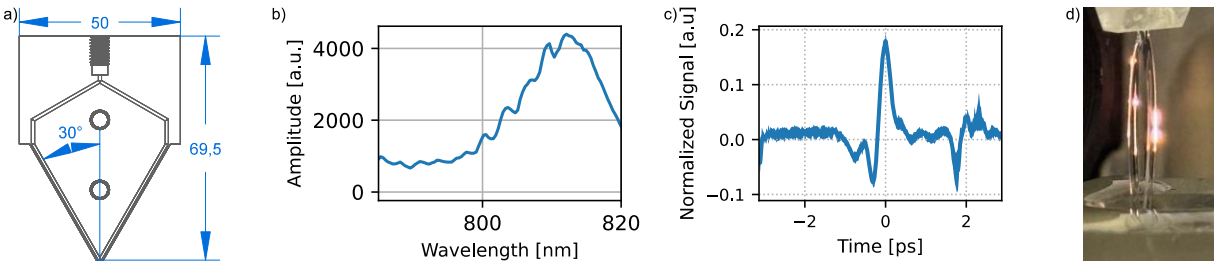

Figure 1 a) Shows the design for the printed nozzle. b) Spectrum of the Fabry-Pérot Oscillations for the Thickness measurements. c) Time Domain THz Measurement of a Saturarted Sugar solution. d) Picture of the Flat liquid sheet formed by the nozzle.

REFERENCES

1. Masato Kondoh and Masaaki Tsubouchi, "Liquid-sheet jets for terahertz spectroscopy," Opt. Express 22, 14135-14147 (2014)