Terahertz near-field microscopy based on an air-plasma dynamic aperture
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As a novel far-infrared inspection method, the development of terahertz (THz) imaging technology has attracted considerable attention in recent years. With the unique properties of THz radiation, such as non-ionizing photon energies and broad spectral information, this imaging technique has shown powerful application potential in many fundamental research and industrial fields. However, the resolution of THz imaging is always limited due to its long wavelength. The introduction of optical near-field techniques can greatly enhance the resolution, but it is always essential to require that a THz source or detector approach the sample from as far as possible. For soft or liquid materials in biomedical sensing and chemical inspection, these samples may be easily damaged and the THz source or detector may be contaminated in traditional THz near-field techniques. Hence, it still remains a challenge to achieve THz near-field microscopy in wider application fields.

In a new paper published in Light: Science & Applications, a team of scientists, led by Professors Xin-ke Wang and Yan Zhang from Beijing Key Laboratory of Metamaterials and Devices, Key Laboratory of Terahertz Optoelectronics Ministry of Education, Department of Physics, Capital Normal University, Beijing, China, and co-workers have developed a new THz near-field microscopy to achieve THz sub-wavelength imaging without approaching the sample with any devices.

In this THz near-field technique, a cross-filament was formed by two cross air-plasmas, which opened a dynamic aperture to modulate the intensity of a THz beam on a sample surface. When the cross-filament was close enough to the sample surface, THz imaging with the resolution of tens of microns was fulfilled. Taking advantages of this technique, the limitation of the sample choice was effectively removed in traditional THz near-field imaging and sample damage from the cross-filament was minimized.

To check the performance of the technique, four different kinds of materials were measured and their THz sub-wavelength images were successfully acquired, including a metallic resolution test chart, a semiconductor chip, a plastic pattern, and a greasy spot. In addition, the technique is also suitable in principle for an encapsulated sample, if its packaging is transparent to THz and visible light. Therefore, it could be anticipated that the reported method will...
significantly broaden applications of THz near-field microscopy, e.g., biomedical sensing and chemical inspection.

More information: Xin-ke Wang et al, Terahertz near-field microscopy based on an air-plasma dynamic aperture, *Light: Science & Applications* (2022). DOI: 10.1038/s41377-022-00822-8

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