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Imaging with a Talbot interferometer using THz radiation

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THz radiation is already used for spectroscopy and imaging applications. In particular, several imaging techniques have been already considered at these wavelengths for industrial and security applications, each one with specific advantages and drawbacks. Indeed, thanks to the high penetration of the THz radiation, a condition similar to X-ray radiation, it is possible to consider different optical layouts working at extremely long wavelengths.

We present here a novel THz imaging system based on the Talbot interferometry layout, a powerful method already established in the x-ray domain. Taking advantage of the non-ionizing nature of the THz waves, it may allow collection of images overcoming drawbacks of x-rays. Using a quite simple setup based on one or to gratings it is possible to demonstrate that both phase and amplitude information of an object can be simultaneously obtained within a large field of view. However, contrary to a X-ray Talbot interferometry, the best spatial resolution of a Talbot Interferometer in the THz range is in the micrometre range, mainly limited by the wavelength used. Actually, the field of view of this THz imaging system is comparable to the beam size and may reach dimensions of few cm. Associated to a tomo-synthesis method, such instrument could also obtain three dimensional phase and amplitude information in a short time, e.g., within ps to ms with no dose. Moreover, this optical layout overcomes the limitations of extremely long scans or of complex optical layouts as required by the imaging of large objects.

An imaging device in THz domain may offer many opportunities in materials science and in particular, in biological and medical studies, possibly enabling the continuous monitoring of a living system because of the lack of dose released to the sample under investigation. Coupled to a high flux free electron laser (FEL) source a THz-based Talbot interferometer should be able to resolve very tiny difference in the refraction index and the transmission of a sample. The main limitations of this approach remain the maximum available spatial resolution and the maximum sample thickness that can be probed.

In the framework of the Bilateral Cooperation Agreement between Italy and Japan of the Italian Ministry of Foreign Affairs (MAE) for the years 2017-2019 we are already working to perform the first test of a Talbot interferometer in the THz energy domain using the FEL's available at the Institute of Scientific and Industrial Research (ISIR) of the Osaka University.

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