Technology Offer

Higher Power Output and Simple Setup: New Source of Terahertz Radiation

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A novel concept for an efficient source of terahertz radiation was developed that is simple, powerful, and easy to use. It improves the possibilities to use THz radiation in science, medicine, security, communications, and other specialized applications.

THz radiation is expected to have high potential in various fields of science and technology. However, respective sources typically require highly specialized and complicated components like single crystals or cryogenics. Furthermore, a high power output is currently difficult to achieve.

Using a simple setup, the new THz source can deliver radiation at higher power. According to the novel approach, a commercial pulsed laser is directed onto a thin film and the resulting temperature gradient together with the transverse thermoelectric effect (TTE) are used to generate THz radiation.

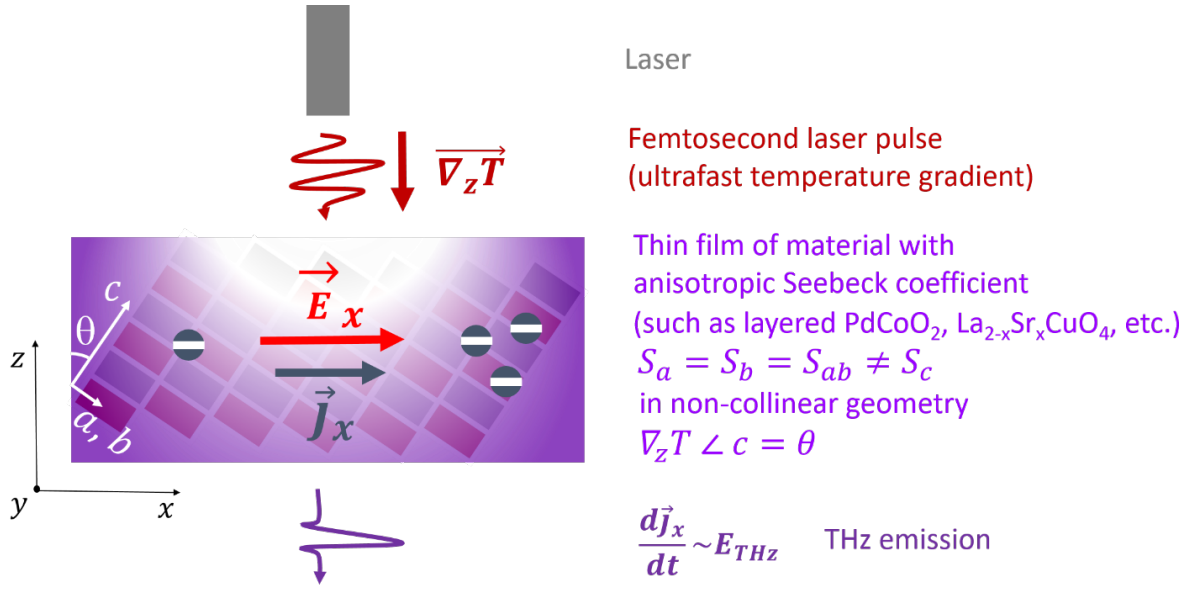

Fig. 1: Schematic description of method for the generation of THz radiation based on the transverse thermoelectric effect – TTE THz generation.

Advantages

- No complex components
- High power output
- Compatible with standard commercial pulsed lasers
- Thin film material widely available

Applications

- Spectroscopy
- Nondestructive material testing
- Communication
- Imaging
- Security

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Background

The search for efficient sources in the THz frequency range is actively pursued in both science and technology due to the significant benefits of THz radiation in applications such as spectroscopy, object imaging or fast data transfer. However, state-of-the-art THz sources require specialized equipment and conditions such as expensive high-quality single crystals (often toxic), lithography for micro- or nano-structuring, application of external fields or cryogenics. In addition, the output power of the most used THz sources is limited and difficult to enhance.

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A novel concept for a high-power THz radiation source has been developed to overcome the aforementioned shortcomings. It is based on the transverse thermoelectric effect and can be realized in an uncomplicated arrangement with standard components.
As shown in figure 1, the source assembly comprises a thin film and a pulsed laser. The latter is emitting femtosecond pulses in the optical range thus allowing for the use of standard commercial components. When irradiating the thin film, a laser pulse causes an ultra-fast temperature gradient in the material. The thin film material needs to have an anisotropic Seebeck coefficient in order to show the transverse thermoelectric effect. Various, widely available materials are fulfilling this requirement.
According to the transverse thermoelectric effect in such a thin film material, the temperature gradient triggers an electric field E_x and an electric current j_x perpendicular to the temperature gradient. This rapid charge displacement emits radiation in the THz range and a respective arrangement can thus be used as a radiation source.
Being based on the pulsed laser and the thin film only, the invention allows for an uncomplicated yet powerful THz radiation source that can be used in various applications in industry, medicine and beyond.

Patent Information

EP *(EP4086699A1)*, PCT

Publications

P. Yordanov *et al.*, *“Intense terahertz radiation via the transverse thermoelectric effect”*, arXiv preprint arXiv:2208.01480 (2022)

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