

[Invited paper] Non-destructive inspection of chemicals in mail envelopes using THz parametric generator

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For years, we have worked on the development of a high-power THz-wave source, based on parametric processes in a LiNbO₃ crystal. In 2001, we created an injection-seeded THz-wave parametric generator (is-TPG) with 300mW output. Recently, the peak output power of is-TPG approached 100 kW by introducing a new pump laser; a microchip YAG laser with shorter pulse width. Is-TPG is a monochromatic widely tunable THz wave source and can obtain THz spectra directly over a relatively wide detection area. Therefore, the spectra from the contents contained in covering materials that refract, diffract, or scatter THz waves can be measured using is-TPG. THz wave parametric generation with an is-TPG uses a near-infrared (NIR) pump beam and seed beam input to the MgO:LiNbO₃ crystal. In contrast, the THz parametric detector uses a THz wave as the seed beam instead of a NIR beam. In the detection configuration, when the pump beam and THz wave are input into the crystal, the THz wave is upconverted to the NIR idler beam by parametric processes in the crystal that are measured using a NIR detector. This THz generation and detection scheme has allowed us to develop a high-dynamic range THz wave spectroscopic system that can be used for spectroscopic imaging of chemicals hidden in thick envelopes. Recently, we have improved the sensitivity of the THz parametric detector drastically using a multistage configuration in order to suppress the spontaneous THz emission and enhance the gain. In our new system, the THz parametric detectors were divided into two parts, i.e., for the up-conversion (pre-amplifier) and for the main amplifier. THz waves were upconverted to a NIR idler beam in the first part of the set-up. An iris positioned behind the upconverted region passed the idler beam and blocked the broadband spontaneous THz emission. Thus, in the amplification region, only the desired idler beam was clearly amplified. The amplified detection idler beam was then measured by a NIR beam profiler. This ultra-sensitive detection enables us to see through a thicker obstacle such as EMS envelope or cardboard box in which illicit drugs may be hidden.