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Terahertz-wave Applications Enabled by Photonics

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As we have seen over-quarter century of research and development of terahertz (THz) waves, whose frequency bands range from 0.1 THz (100 GHz) to 10 THz, lots of practical applications such as spectroscopy, imaging and communications have been initiated and led by photonics technologies particularly in the infrared lightwave region [1-5]. This is firstly because that generation and detection of broadband THz waves are efficiently enabled by lightwave-to-THz-wave (and vice versa) converters such as photoconductors and photodiodes in combination with pulse and continuous-wave (CW) lasers. Although, in the last 10 years, electronics-based THz technologies have gained a great deal of attention to make THz systems and subsystems more compact and cost-effective with a steady progress of semiconductor devices and integrated circuits, photonics technologies have still been playing a key role in exploring THz waves in both scientific and technological aspects.

This lecture describes how effectively photonics technologies are implemented not only in generation, detection and transmission of THz waves, but also in system applications such as communications, measurements and imaging. In addition, some unique approaches, which utilize concepts or physical phenomena established in the lightwave region in order to enhance functionality and performance of THz applications, are presented. Finally, in order to compete and/or coexist with electronics, recent challenges in photonic integration technologies are described, which include monolithic and hybrid integration schemes.

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