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Optoelectronic devices for future telecommunications in the sub-terahertz and terahertz range

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The progressive congestion of the radio wave bands up to the microwave range stimulates research and development of new devices for the millimeter and sub-millimeter wave bands corresponding to sub-terahertz and terahertz bands. These ranges are particularly interesting for high data rate and short-range communications [1]. In order to develop these communications two main problems should be addressed for the transmitter: (1) the generation of sufficient power at the high carrier frequency, (2) the modulation of this carrier at the required data rate which is generally higher than 1 Gb/s.

Optoelectronics devices can contribute to solve these problems. In particular the modulation applied to a light carrier can be transferred to a mm or sub-mm wave carrier thanks to the photomixing process. In this approach the modulated laser light illuminates a fast photodetector and a second laser beam illuminates at the same time the photodetector. A beatnote is generated at the difference frequency between the two laser frequencies and generates a photocurrent at this frequency. The photocurrent drives an antenna and a modulated mm or sub-mm wave beam is radiated and carries the data. We have developed uni-traveling carrier photodiodes (UTC-PD) that are well suited for this application. The most recent approach is based on a resonant optical cavity: the semiconductor heterostructure is placed between two metallic mirrors that are also used as electrodes [2]. A power approaching 1 mW can be generated with these devices around 300 GHz with a record efficiency.

We have used UTC-PD in data transmission experiments. A 32-Gbit/s data transmission with 16-QAM modulation has been demonstrated with a link distance of 25 m at a carrier frequency of 385 GHz [1]. Higher performance is envisaged in the near future.

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2. P. Latzel, F. Pavanello, M. Billet, S. Bretin, A. Beck, M. Vanwolleghem, C. Coinon, X. Wallart, E. Peytavit, G. Ducournau, M. Zaknoune, J.-F. Lampin, "Generation of mW level in the 300-GHz band using resonant-cavity-enhanced unitraveling carrier photodiodes," *IEEE Transactions on Terahertz Science and Technology*, **7**, 6, November 2017, pp. 800-807, doi: 10.1109/TTHZ.2017.2756059