Microwave-Photonic Oscillators for Radio-over-Fiber Access Networks

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MICROWAVE-PHOTONICS (MWPs) brings together optoelectronics and radiofrequency engineering to provide functions at microwave frequencies that are very complex or even not practical in the electric domain [1]. The integration of fibre-optic and wireless networks make possible the transport and distribution of radio or wireless signals over optical fibre, taking advantage of optical fibre reduced weight and cost, low and constant attenuation over entire microwave frequency range, electromagnetic interference immunity, and high data-rate transport capacity [2]. Radio-over-fiber (RoF) technology promise unlimited access to broadband wireless communications. Its application includes the last mile solutions, improvement of radio coverage and capacity, and backhaul of current and next generation wireless networks.

The advantages of optical fibre as a transmission medium makes it the ideal solution for efficiently transporting radio broad-band data and control signals from a central station to remotely located base station antenna sites [2]. Wireless RoF technology is being considered for cellular networks, indoor distributed antenna systems and wireless local area networks, as well as fixed and mobile broadband networks that provide very high bandwidth services. Technical challenges for RoF systems are the development of suitable technologies and architectures for efficient conversion and distribution of radio signals, while reducing the complexity and cost of electronic/RF and optoelectronic interfaces hardware located at the remote BS antenna site. This is of paramount importance for wireless systems designed to provide very high bandwidth services requiring the installation of a large number of BSs [2].

In recent developments on a hybrid optoelectronic integrated circuit (OEIC) consisting of a laser diode (LD) driven by a resonant tunnelling diode (RTD) biased in the negative differential resistance region, we have demonstrated the RTD-LD optical output emulates the RTD nonlinear characteristics, which gives rise to a variety of additional optoelectronic operation modes, including optoelectronic voltage-controlled oscillator (OVCO) [3], injection locking [4], period-adding [5], and chaotic carriers generation [6], with potential applications in optical chaotic communications.

Here we describe experimental investigation of a low cost and low power consumption microwave-photonic oscillator capable of operate as dual-function transceiver at the base station. This microwave-photonic oscillator is based on the integration of resonant tunnelling diodes (RTDs) with a photodetector and a laser diode with the LD being driven by the RTD-photodetector (RTD-PD) oscillations which can be controlled by both the optical injected signals and the RTD biasing voltage. The RTD-PD-LD circuit is capable to acts both as wireless to optical (W-O) and optical to wireless (O-W) converters, unifying the functions of optical generation, photo-detection and optoelectronic self-oscillations. The RTD-PD oscillator is optically injection locked and feeds the laser diode which serves as a modulator. The following three aspects of the voltage controlled optoelectronic self-oscillators are being investigated: i) electrical and ii) optical injection locking to improve the spectral purity of the oscillator – phase noise lower than -100 dBc/Hz at 100 kHz offset from carrier was demonstrated at 1.4 GHz; iii) Convert analogue and digital information carrying signals from electrical/optical to optical/electrical domains.

REFERENCES