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The transistor-injected quantum cascade laser: A novel three-terminal device for mid-IR wavelengths through THz frequencies

The quantum-cascade laser (QCL) has emerged as an important device for the generation of coherent light over operating bands from mid-IR wavelengths through THz frequencies. Wide-ranging applications in chemical detection and security have been enabled by the availability of these devices. At the same time, the device has certain limitations that are fundamental to its two-terminal nature and reliance on engineered quantum states that depend strongly on electric field, and as a consequence bias voltage. A promising enhancement to the QCL will be discussed that utilizes the transistor effect in a novel three-terminal n-p-n transistor structure to separate the field control from the current amplitude. This separation is achieved through placing the device cascade region in the reverse-biased base-collector junction of a hetero junction bipolar transistor (HBT), where the amplitude of the current flowing through the cascade region is controlled by the emitter-base bias. The ability to separately modulate the amplitude (emitter-base) and frequency (base-collector) creates unique opportunities for novel applications. The device design also allows a reduction of the doping level in and around the cascade region, which is ultimately expected to reduce free carrier absorption and improve wall-plug efficiency.

Biography

John Michael Dallesasse has over 20 years of experience in the Optoelectronics Industry, and has held a wide range of positions in technology development and management. Prior to joining the Department of Electrical and Computer Engineering at the University of Illinois in Urbana-Champaign, he was the Chief Technology Officer, Vice President, and co-founder of Skorpios Technologies, Inc., a company involved in the integration of compound semiconductor materials with silicon in a CMOS-compatible process. His research at the University mainly targets photonic-electronic integration and novel coherent emitters for the mid-IR. His technical contributions include, with Nick Holonyak, Jr., the discovery of III V Oxidation, which has become an important process technology in the fabrication of high-speed VCSELs. He has over 60 publications and presentations, and 29 issued patents. He is a Fellow of the IEEE and OSA.

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