High performance Master Oscillator Power Amplifier and Plasmonic Collimated Quantum Cascade Lasers

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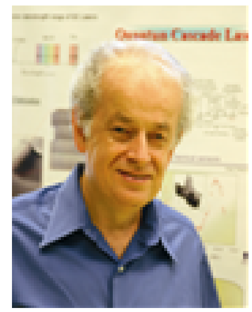
BIOGRAPHY



Federico Capasso is the Robert Wallace Professor of Applied Physics at Harvard University, which he joined in 2003 after a 27 years career at Bell Labs. His research has spanned a broad range of topics from applications to basic science in the areas of electronics, photonics, nanoscale science and technology including plasmonics, metamaterials and the Casimir effect. He is a co-inventor of the quantum cascade laser; he recently performed the first measurement of the repulsive Casimir force and with his group demonstrated powerful generalizations of the laws of reflection and refraction applicable to metasurfaces. He is a member of the National Academy of Sciences, the National Academy of Engineering, a fellow of the American Academy of Arts and Sciences; his awards include the King Faisal Prize for Science, the APS Arthur Schawlow Prize, the IEEE Edison Medal, the Franklin Medal, the Berthold Leibinger Zukunftspreis (the future prize), the Julius Springer Prize for Applied Physics, the Jan Czochralski Award of the European Material Research Society for lifetime achievements in Materials Science.

TECHNICAL ABSTRACT

In the talk I will review recent research of my group on novel approaches to high power single longitudinal, single transverse mode QCLs and on applications of plasmonics to achieving high beam quality (low divergence, multibeam operation etc.). To reach high output powers, which is important for example for stand-off detection large area devices can be fabricated which are pumped with high currents. The drawbacks of this approach are a decreased beam quality arising from high order transversal electromagnetic modes and decreased wall plug efficiencies. Two section devices, where one section acts as the pumping section (referred to as master oscillator (MO) section) and the other section serves as a power amplifier (PA) section were fabricated.. The MO section features a DFB grating to ensure single-mode emission. We report single longitudinal-mode $\lambda = 7.26$ μm MOPAs at 300 K reaching output power of several Watts. The devices display single-transverse-mode emission at TM00.

I will also discuss our approach to reduce the divergence and improve beam quality of QCLs using plasmonic collimators. High peak power in excess of 1 Watt with divergence angles not exceeding 5 deg in the vertical and horizontal directions have been achieved in 8 micron wavelength QCLs. Importantly the fabrication of a collimator on the facet of the QCL does not produce any deterioration in output power and in fact leads to an enhancement of the output power due to optimized optical impedance matching. I will discuss plans to integrate our novel collimator designs of the facet of QCL MoPAs.

This work was done in collaboration with S. Menzel, B. Gokden, R. Blanchard of my group; C. Pfluegl, L. Diehl, now with EOS Photonics; A. Goyal, C.Wang, A. Sanchez, G. Turner of MIT Lincoln Laboratory; T. Edamura, S. Furuta, N. Akikusa, M. Yamanishi of Hamamatsu Photonics

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