A single-mode BCB-embedded antenna-integrated continuous wave quantum cascade laser for heterodyne measurement at 4.745 THz

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Abstract—Nowadays, the demanding of an efficient source for the terahertz (THz) region is increasing. Such a source is particularly important for astrophysical application. Indeed, the THz spectrum includes important atomic cooling lines which detection gives information about interstellar mediums. This work purpose is to develop a monochromatic source for detecting [OI] cooling line at 4.745 THz thanks to a heterodyne measurement setup. The source is a THz Quantum Cascade Laser (QCL) based on a four quantum well structure. The single modality of the laser is achieved engineering a double metal cavity, which is composed by a Distributed Bragg Reflector (DBR), a main region with a second order lateral grating, a multi-section tapering and a first order lateral grating used as a front reflector. Moreover, the whole structure is embedded in Benzocyclobutene, also known as BCB, an insulating THz-transparent organic polymer, which is essential for the deposition of a patch-array antenna together with the top metal contact. The antenna function is to out-couple the lasing mode in a single lobe vertically emitted beam. The device is also able to operate up to 55 K in continuous wave and it is tunable up to 3.5 GHz with a peak power close to 2.0 mW.