A low-temperature-grown (LT) GaAs based photomixer as a local oscillator (LO) for a hot electron bolometer (HEB) mixer at 700 GHz

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A LT-GaAs based traveling-wave photomixer [1, 2] was applied to pump a NbTiN-based membrane-mounted and waveguide-integrated HEB mixer of 2 μm^2 area. [3,4]
To couple most of the LO power to the mixer, a Martin-Puplett diplexer was used together with a Gaussian telescope, consisting of two 90°-offaxis mirrors transforming the beam waist of the photomixer to the one of the mixer horn. The diplexer, situated in between the two mirrors, showed a transmission of 75% at an IF of 1.1 GHz in the right polarisation. The Gaussicity of the photomixer bow-tie antenna beam pattern was calculated to 65 %. With 1 µW output of the photomixer the HEB was pumped to estimated 70 % of the optimal level at which it was characterised with a multiplier-LO and showed T_{sys}=1200 K. The sub-optimal pump level led to T_{sys}=1500K, which is only moderately increased. According to the above numbers the estimated power was 500 nW at the HEB dewar window in the fundamental Gaussian mode, while the absorbed power in the HEB was determined to 300 nW with the isothermal method.
Apart from the experiment with the HEB, best photomixer samples were shown to produce 2µW of power at 700 GHz, which, according to the above results, must be sufficient power for pumping the investigated HEB optimally. The THz power was measured with a calibrated large-area 4.2K-InSb-bolometer with a Winston cone, which is sensitive also to the calculated 35% of higher modes from the photomixer antenna.
Operated near their voltage and IR power limits our photomixer chips where found to have a statistical life-time of a few days due to electrostatically attracted dust particles in a normal laboratory atmosphere, because a protective IR antireflection coating was not applied up to now due to its poor reproducibility. However, ultimate photomixers will be manufactured with this antireflection coating and thus will be more durable.

References:

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