Capillary quasioptical highpass filter

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Single below-cutoff circular waveguide as a high-pass filter was studied earlier in [1], it was obtained attenuation of 6-12 dB in the pass-band and attenuation of 30-60 dB in the stop-band. Such filter requires input and output horns and adapters if using in quasioptical systems and makes construction rather complicated, of big size, with nonuniform spectral characteristics. Matrix of capillaries can operate as a high-pass filter at millimeter and submillimeter waves without additional adapters. At lower frequencies each capillary can be viewed as a below-cutoff circular waveguide. Array of capillaries do not need any adapters, they are thin and can be inserted in any quasioptical beam-guide. They can be alternative to perforated plates (grids) that should be arranged as 4-6 parallel layers and this pseudo high pass filter is rather a bandpass filter with a bandwidth of about one octave [2]. Industrial manufacturers of multimesh Terahertz filters such as QMC Instruments and TYDEX do not offer high performance highpass filters that are required for cryogenic radiation sources intended for calibration of superconducting bolometers.

We fabricated series of capillary matrix filters with different diameters and lengths of capillaries. Fabrication consists of following steps: electroplating of stainless or nickel-copper capillaries with Ni, filling short piece of 10 mm inner diameter tubewith as many capillaries as possible, soldering of such package with tin-lead alloy, electro-erosion cutting pieces of 1, 2, 3, 4 mm long, final cleaning in ultrasonic bath.

Filters were placed in the waist of a quasioptical beam-guide comprising Backward Wave Oscillator (BWO) radiation source, corrugated horn, four Teflon lenses, and Goley cell detector. Transmission was measured in the frequency range 150-550 GHz. For inner diameter of capillary of 0.7 mm and length of 3 mm the attenuation of such filter was over 40 dB at frequencies below 200 GHz. At frequencies above 350 GHz attenuation does not exceed 5 dB.

References

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2. R.Ulrich, Interference filters for the far infrared, Applied Optics, vol.7, No 10, pp. 1987-1996 (1968).