Development of mm/submm Frequency Selective Filters made with FPC Fabrication Technology

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We report the initial evaluation results of the prototyped mm-wave metal mesh filters, which are designed as a band-pass filter for a mm/submm broadband multichroic camera covering 130−295 GHz.

Band-pass filters are one of the key components for mm/submm wave imaging and spectroscopy instruments, but it typically takes a very long time for its procurement because of the very limited availability of the design and fabrication company. Here we propose a new method to produce a broad-band mm/submm-wave band-pass filters, which exploits recent rapid advancement of commercially available flexible printed electronic circuit (FPC) fabrication technology.

We have simulated transmittance of mesh patterns using the multiphysics simulation software COMSOL RF module. and have prototyped metal mesh filters with the same method for printed circuits. Our pattern design is based on the idea that optical properties of mesh patterns can be simply represented as transmission line equivalent circuits[1]. From electromagnetic field simulations, we concluded that the best mesh pattern for broad band-pass and steep cutoff is a stack of combination layers of hexagonal grid mesh and hexagon with optimal spacing. Our goal here is to fabricate a band-pass filter covering 130 - 295 GHz, but considering the availability of transmittance measurement, we also produced scaled models of the filters covering 260-590 GHz, which is measurable using THz-TDS.

After microscopic inspection of the fabricated patterns, we measured the transmittance using THz-TDS. An example of measured and simulated transmission curves is shown in Fig. 1. We find that the pass-bands were broader than designed because of narrower line widths presumably by over-etching during the fabrication process. This line width narrowing will mitigated by the preceding calibration of the etching process. Measurements also show higher transmittance than that of simulations, and unexpected resonances in bands. By simulations these resonances are qualitatively reproduced in the presence of small (<15º) but non-negligible incident angle, which was assumed to be zero in the original design.

Based on these evaluations, we concluded that the proposed method, which exploits the recent advancement of the flexible printed circuit fabrication technology, is promising to produce mm/submm-wave band-pass filters with a reasonably short turn-around time.

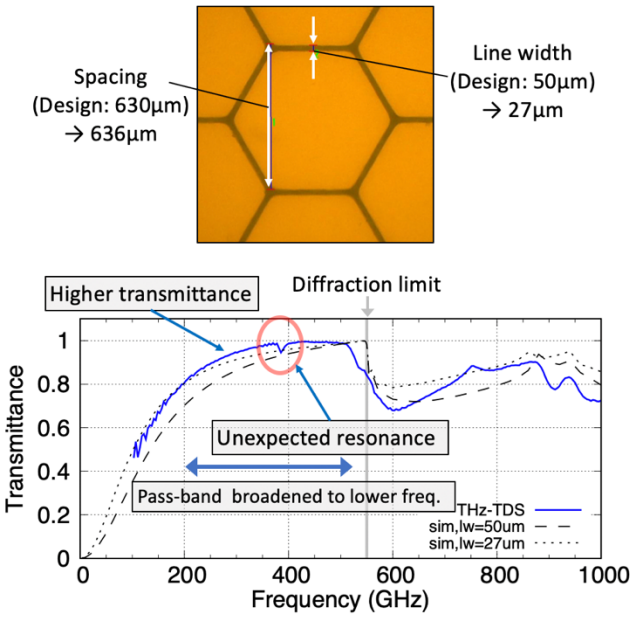

Fig. 1. Top panel: microscopic image of FPC filter prototype. Bottom panel: the transmission curve of a prototype of FPC hexagonal grid filter (solid line) and of simulations (dot lines).

References

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