Study on optimization design of milli-meter wave devices and transmission lines

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Design of milli-meter wave waveguide bandpass filter

In recent years, the development of microwave and millimeter-wave components using a 3D printer has become widespread. Its advantages are that the 3d printed production is lighter than metal and that even complicated shapes can be prototyped.

The purpose of this study is to establish of the manufacture method of millimeter-wave antennas and components using 3D printer and electroless Ni plating. We propose a new structure which is suitable for the 3D printing(Fig.1), and introduce the FDTD method and µGA in its design. The design results are shown in Fig.2. It is confirmed from the prototype and measurement results that the filter properties are obtained with the proposed structure(Fig.3).

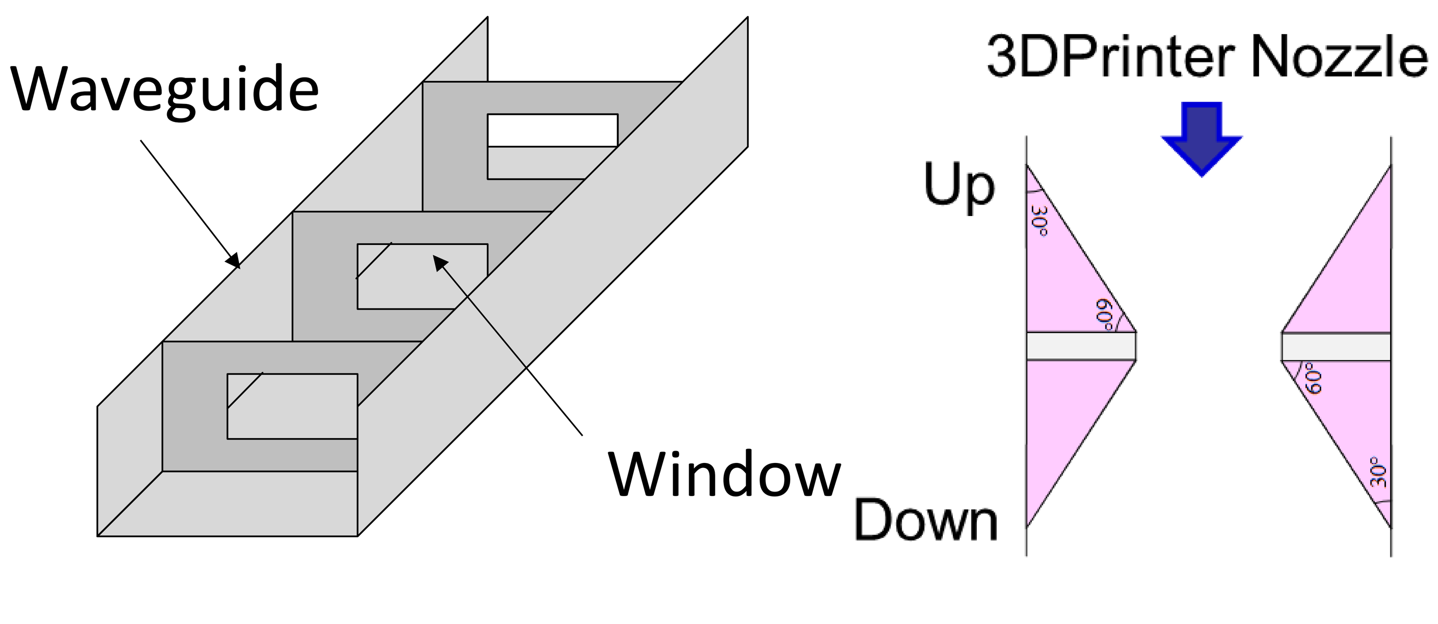

Fig. 1 Waveguide filter and proposed window

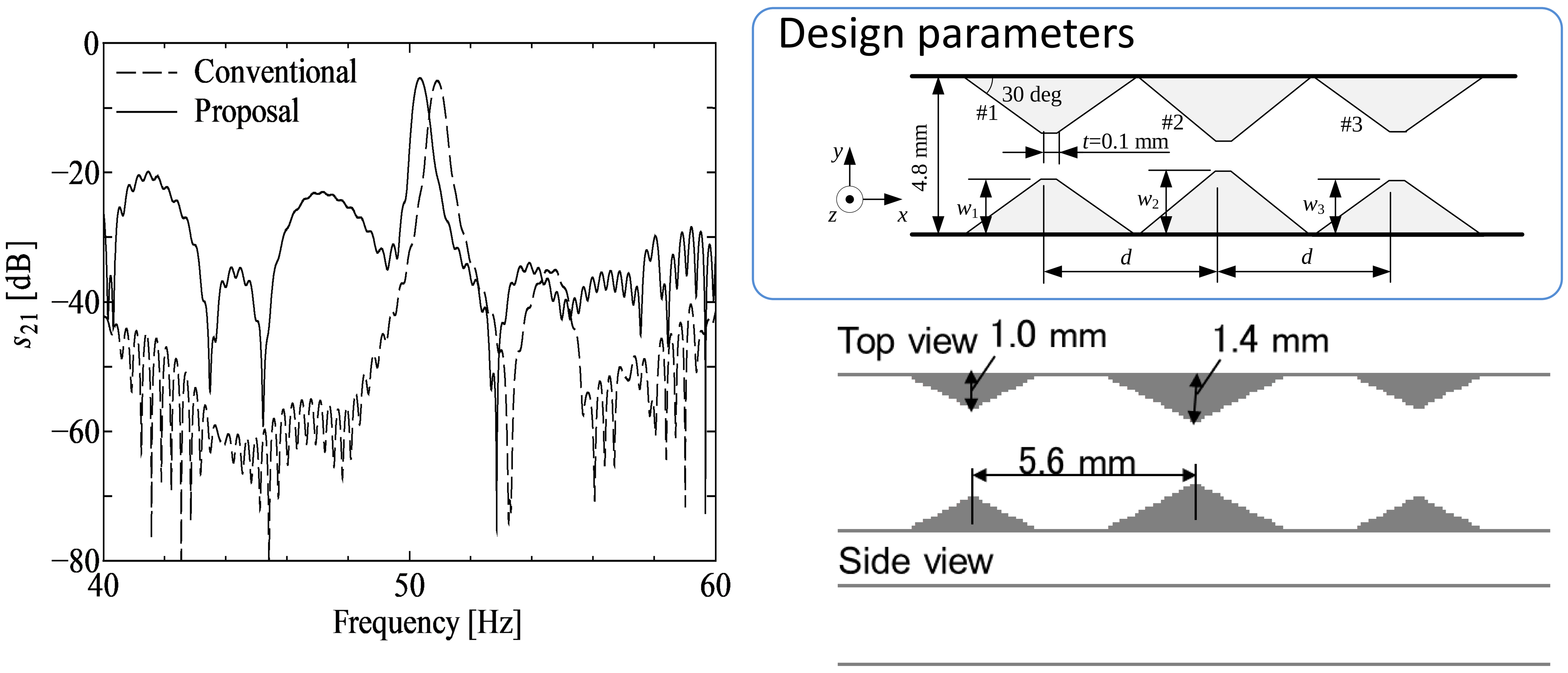

Fig. 2 Frequency characteristics and optimized structure

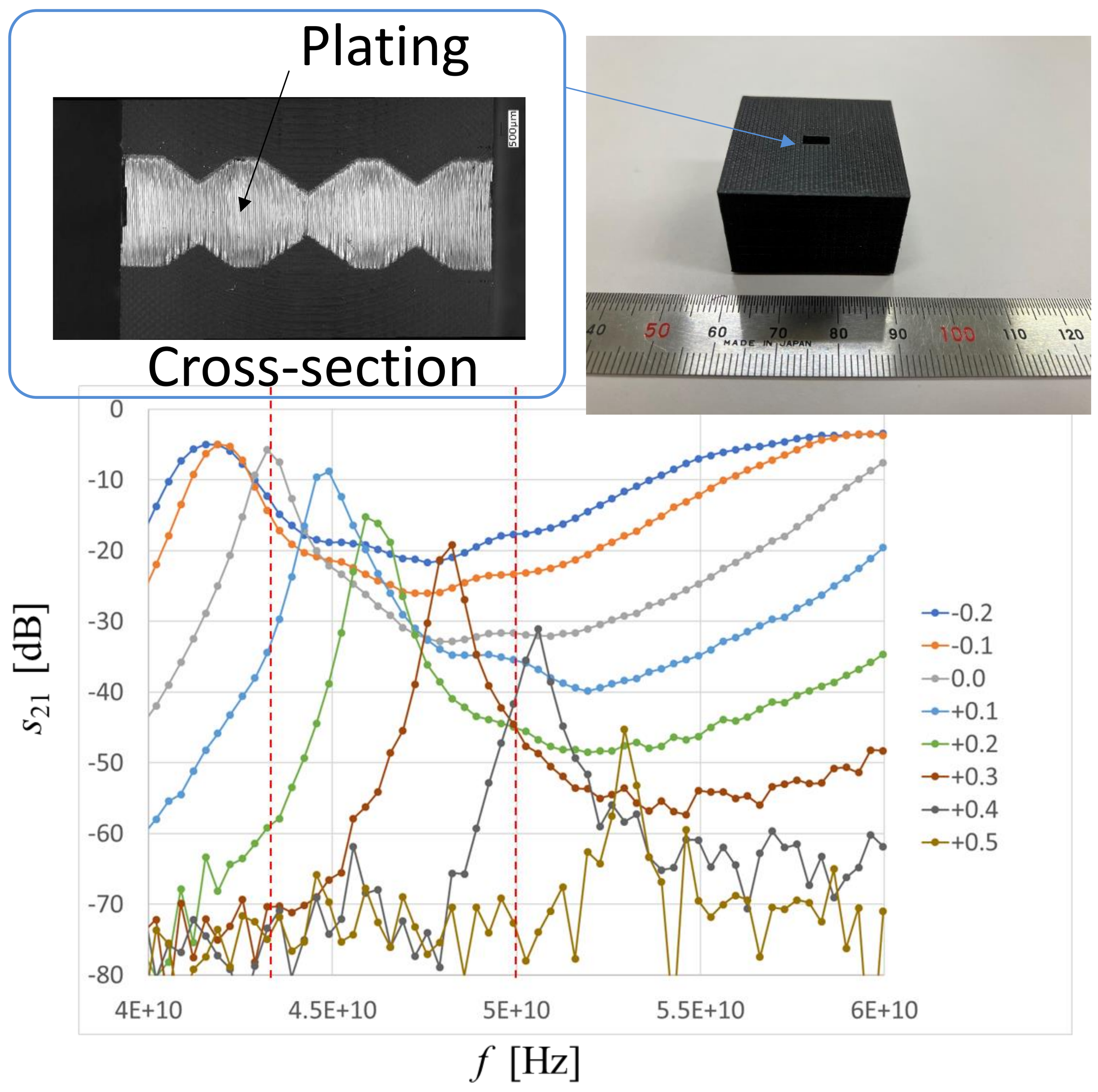

Fig. 3 Measured results and prototype

Design of small band pass filter for milli-meter wave PCB

The purpose of this research is to design a filter for a printed circuit board (PCB) using topology optimization in order to realize the miniaturization of a millimeter-wave device. The FDTD method to create a calculation model for PCB lines and design a 40 GHz bandpass filter. The calculation model places the filter design region on a cut microstrip line on FR-4 substrate (ε_r = 4.4, tan δ = 0.016) (Fig.4). The design region is represented by three materials: dielectric, air, and metal, and the material distribution is expressed using two NGnets (normalized Gaussian function networks). The dielectric material in the design region is set to PLA (Polylactic acid, ε_r=2.6, tanδ=0.003), which is used by 3D printer. The transmission coefficient s_{21} is determined by equation (1). When the gap is 1 mm, It is confirmed that a peak is observed at 40 GHz after the optimization (Fig.5).

$$s_{21} = \left(\frac{V_2}{\sqrt{Z_0}}\right) \Big/ \left(\frac{V_1 + Z_0 I_1}{2\sqrt{Z_0}}\right) \qquad (1)$$

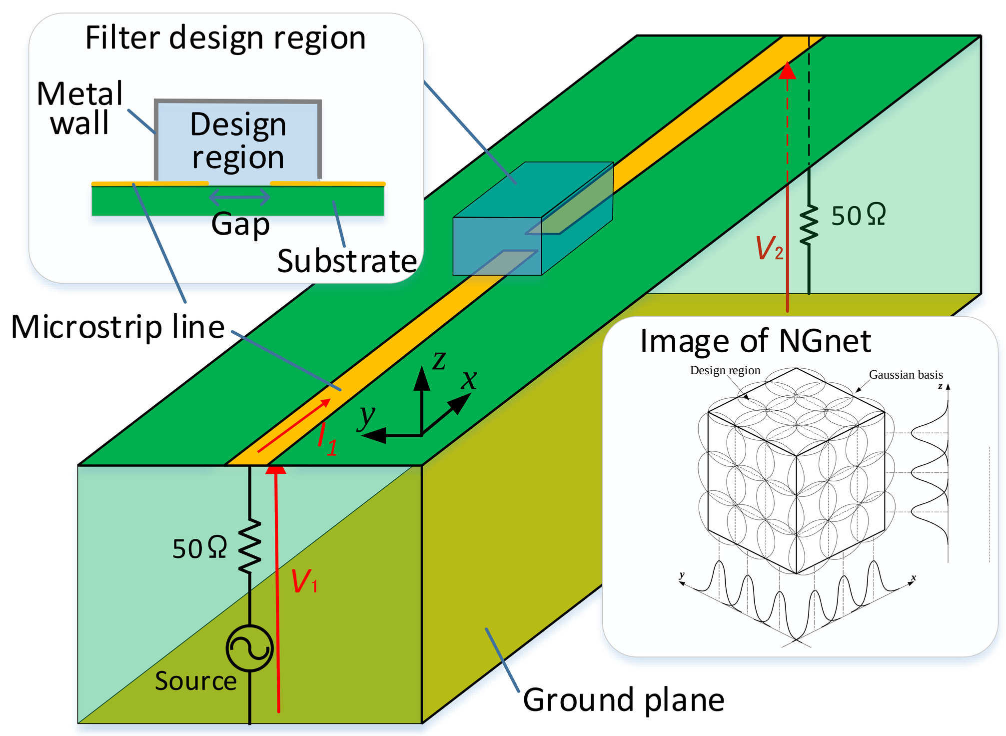

Fig. 4 Calculated model

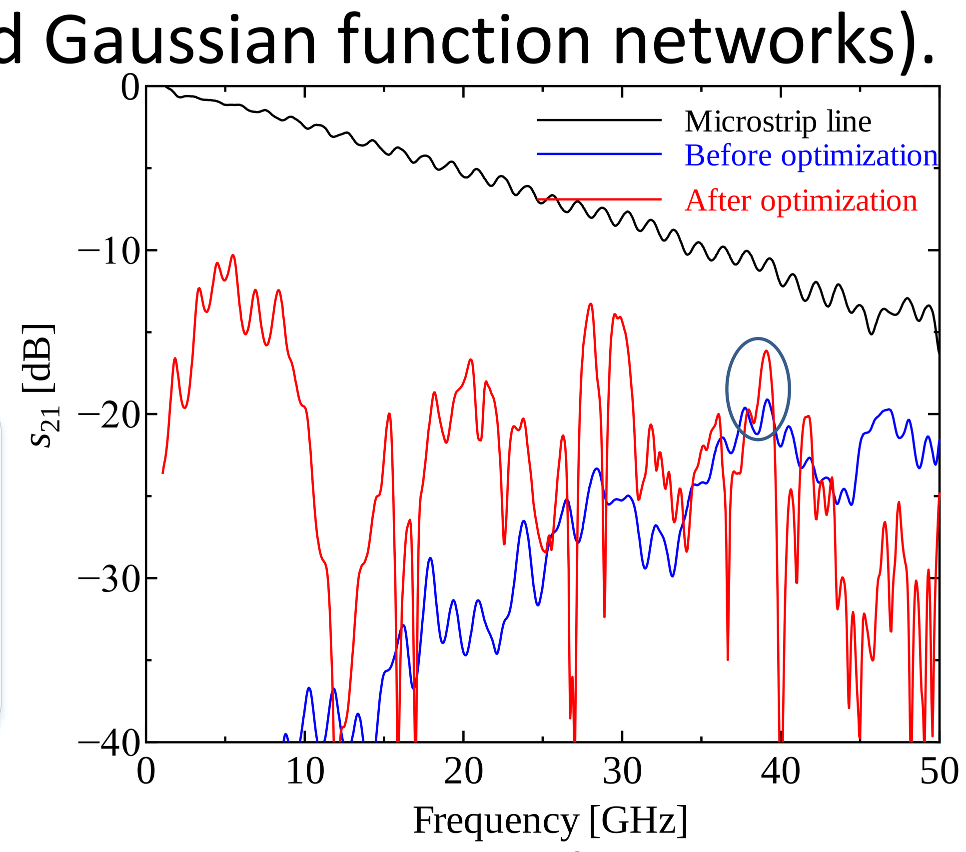

Fig. 5 Frequency characteristics

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