Study on development of millimeter wave antenna using 3D printer

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Purpose and background

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 plating. We report on the design of a waveguide filter (Fig. 1) using a micro GA (Genetic Algorithm) and a prototyping method using a 3D printer.

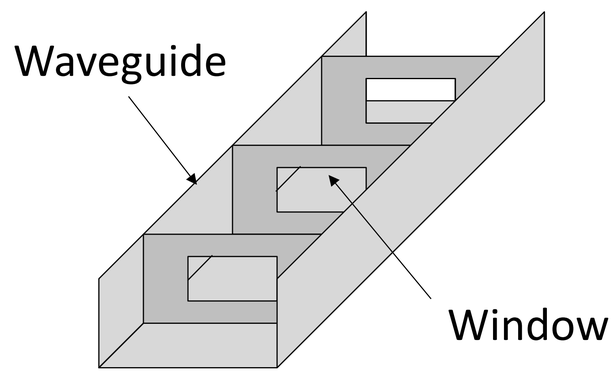

Fig. 1 Waveguide filter

Design using micro GA

The FDTD analysis model used for the design is shown in Fig. 2. The cell size is set to 0.1 mm. The waveguide (WR-15 standard) is set to 3.8 x 1.9 mm and 50 mm in length. Both ends of the waveguide are non-reflective terminator by inserting PML (Perfectly matched layer). A bandpass filter (BPF) is designed in this study. The window width w and height h shown in Fig. 3 are optimized to maximize the transmission of the target frequency (60 GHz) at the observation point using a micro GA. The calculation flow of the micro GA is shown in Fig. 4.

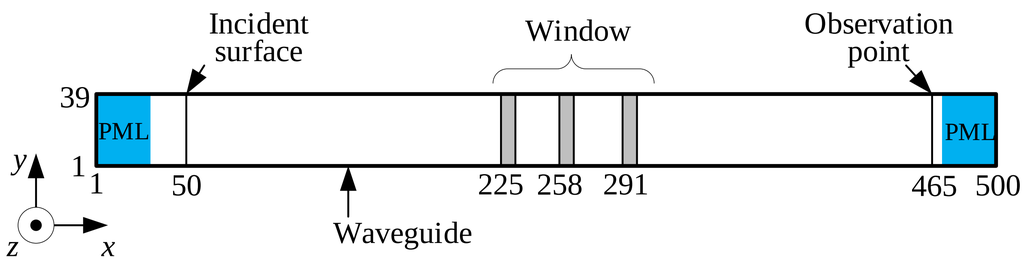

Fig. 2 FDTD analysis model (3 windows type)

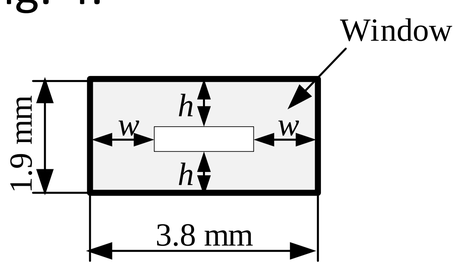

Fig. 3 Dimension of window

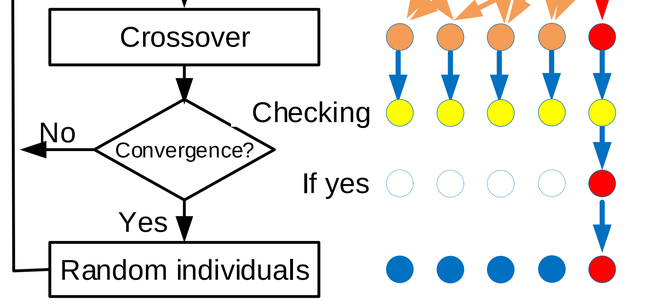

Fig. 4 Flow of micro GA

Prototyping of waveguide filter

A prototype filter was fabricated using 3D printer inside a WR-15 standard waveguide (3.76 x 1.88 mm). Figure 5 shows the CAD drawing drawn based on the design results with five windows type. The outer dimensions of the waveguide is set to 20 x 20 mm in order to fix with a flange. Figure 6 shows the photograph of the prototype. The filament of carbon-filled PLA was used. The prototype results show that a window can be formed at a predetermined position on a narrow waveguide, but it is difficult to print accurately because the filament drooped.

To solve this problem, we propose a sloping window as shown in Fig. 7. We confirmed that the window with the added red area eliminates the drooping of the filament.

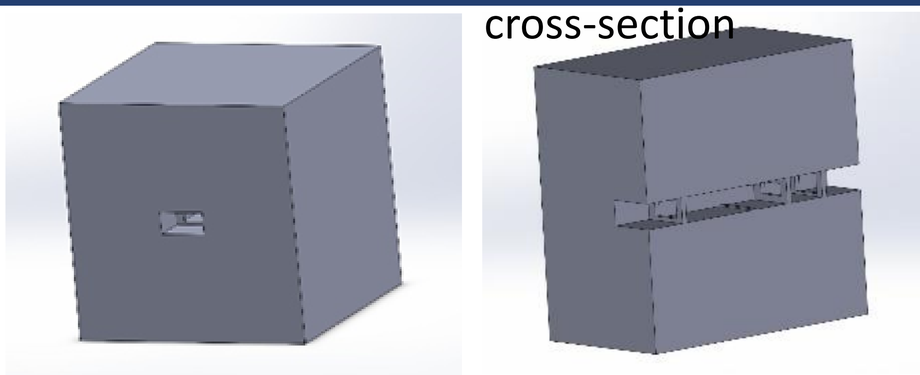

Fig. 5 CAD drawing of waveguide filter

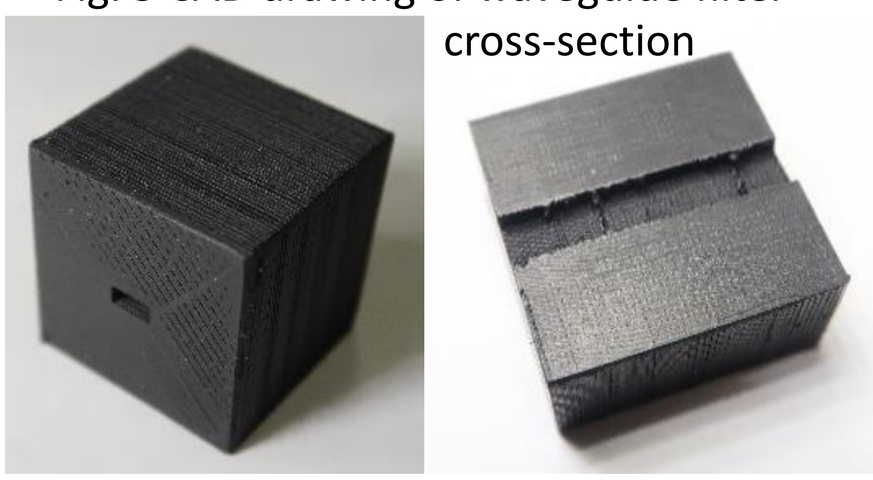

Fig. 6 Prototype of waveguide filter

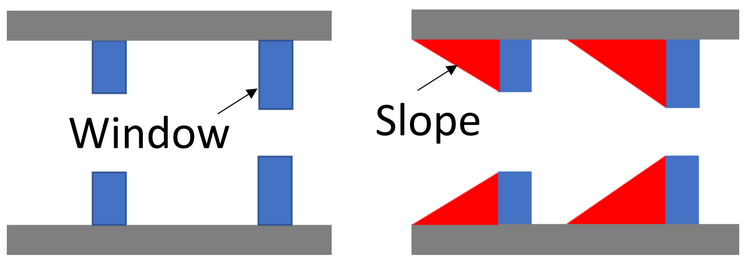

Fig. 7 Improvement of window shape (left: conventional, right: proposal)

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