

EDP1-21

Development of Superconducting Filter for Deep Space Exploration Ground Station Receiving System

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We have developed a superconducting filter for deep space exploration receiving system. JAXA (Japan Aerospace eXploration Agency) is currently developing new antenna for deep space exploration. New antenna requires high performance filter which has compact size, low insertion loss and high selectivity. In this study, we developed a superconducting filter which satisfied these requirements and design specification accurately. The filter was fabricated using $\text{YBa}_2\text{Cu}_3\text{O}_7$ thin film on $r\text{-Al}_2\text{O}_3$ substrate. An $r\text{-Al}_2\text{O}_3$ substrate has strong mechanical strength, high chemical stability and low cost. However, there is the problem that it is difficult to agree well with the simulated and measured result, because of dielectric anisotropy, so that there is no practical superconducting filter using $r\text{-Al}_2\text{O}_3$ substrate. Therefore, we proposed the design method which consider dielectric anisotropy of the substrate. In addition, to improve the degradation of the frequency response due to the discrepancy of the substrate thickness and dielectric constant difference between design and fabrication we used dielectric rods. Figure 1 shows the simulated and measured frequency responses of the filter. The measured results agree well with the simulated ones. We used the dielectric rods to reduce the return loss. Finally, our filter was adopted for the receiving system of the JAXA Ground Station for Deep Space Exploration and Telecommunication (GREAT).

Acknowledgment

This work was executed in the development of low noise amplifier equipment for JAXA GREAT project.

We would like to thank the member of GREAT project team.

