Transfer printing infrared light sources based on thermally excited Tamm plasmon polaritons

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***Abstract*— We report transfer printing infrared light sources based on thermally excited Tamm plasmon polaritons. By using the transfer printing, it is possible to fabricate a laminated structure made by thick films more easily compared to the conventional device fabrication.**

I. INTRODUCTION

In recent years, attention has been focused on the development of devices using Tamm plasmon polaritons (TPPs) [1]. TPPs can be more easily excited by stacking a metal with a distributed Bragg reflector (DBR) [2]. However, it takes a lot of time to fabricate a laminated structure. Therefore, we solved the problem by using the transfer printing method. This method enables to transfer a microstructure from an existing device to any devices. [3]. In this study, we fabricate transfer printing infrared light sources based on thermally excited Tamm plasmon polaritons .

II. RESULTS

Figure 1 shows the transfer printing method. First, PVA was coated by spin-coating and DBR was laminated by sputtering on the substrate. Polymethyl methacrylate (PMMA) was deposited on the DBR. After that, we cut the deposited substrate. Next, PDMS was laminated on the substrate and the DBR was peeled off from the substrate in the water. Al and Si were laminated on the SiO2 substrate in advance. We transferred the DBR to the prepared substrate and remove PMMA by oxygen plasma ashing. This method made it possible to fabricate a two-layered Tamm structure by sputtering at one time

Figure 2 shows optical image of TPPs structure made by the transfer printing method. The DBR was stacked on the substrate prepared beforehand. The TPPs structure consists of two layers that are SiO2 and Si were alternately laminated on Al film. The design wavelength of the DBR was 50 THz, and the value obtained by dividing 1/4 of the design wavelength by the dielectric constant of each material was used as the film thickness.

Figure 3 shows the electromagnetic field analysis of TPPs structure aimed at 50THz. A reflection peak appeared at the target frequency. Figure 4 shows the absorption of TPPs structure made by the transfer printing method. It was measured with a Fourier transform infrared spectrometer (FTIR). It was found that the substrate fabricated by the transfer printing method has an ideal absorption as Kirchhoff's law states that the absorption and the reflectivity are equal. Figure 5 shows the radiation power of the TPP structure by the transfer printing method. It was measured with a FTIR. A peak of the radiation power appeared at 50 THz, which is in good agreement with the resonant frequency of the designed TPP structure.

III. SUMMARY

We fabricate transfer printing infrared light sources based on thermally excited Tamm plasmon polaritons. These techniques have made device fabrication easier. In the future, it will be possible to create devices in lower frequency bands, which will be effective for THz analysis such as gas sensing

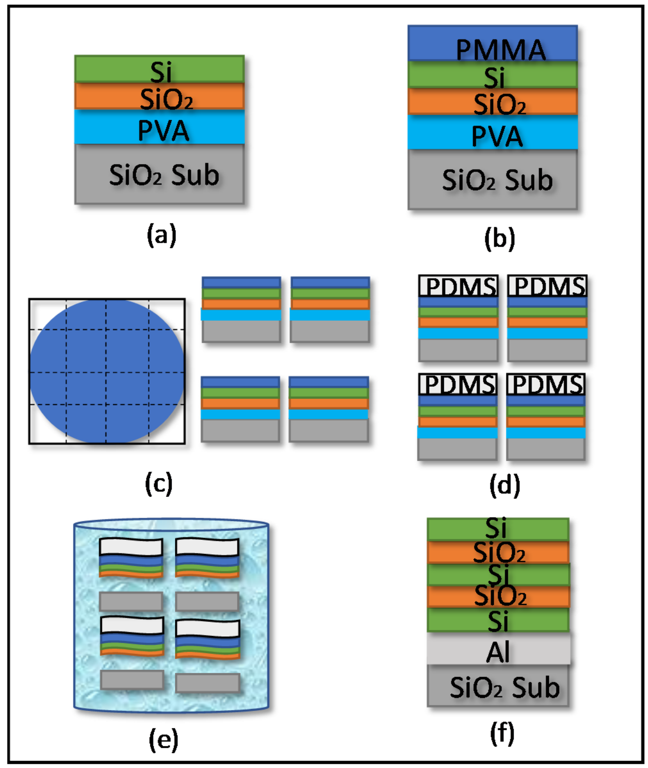

Fig 1 . Schematic illustrations of Transfer printing method (a) PVA was coated and DBR was laminated(b) PMMA deposit on DBR(c)The deposited substrates are cut(d) PDMS was laminated on substrates(e) DBR peeled off from substrates(f) The DBR transfer on SiO2 by deposited Al.

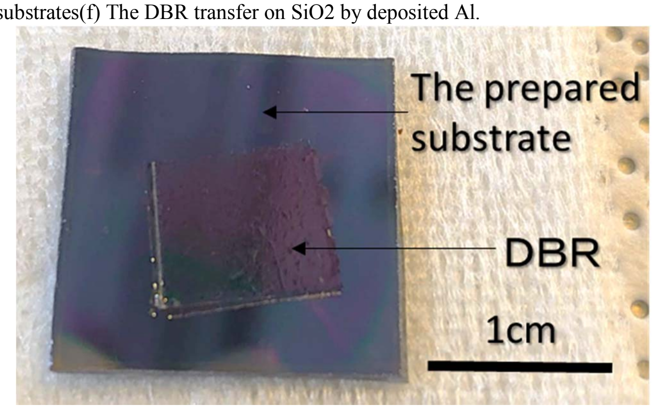

Fig 2. Optical image of TPPs structure made by the transfer printing method.

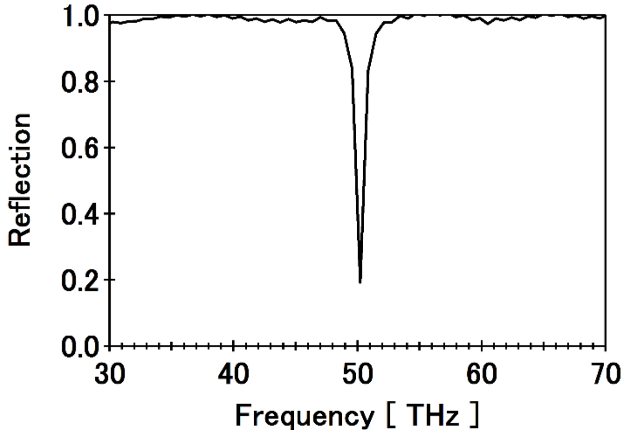

Fig 3. Electromagnetic field analysis of TPPs structure aimed at 50THz.

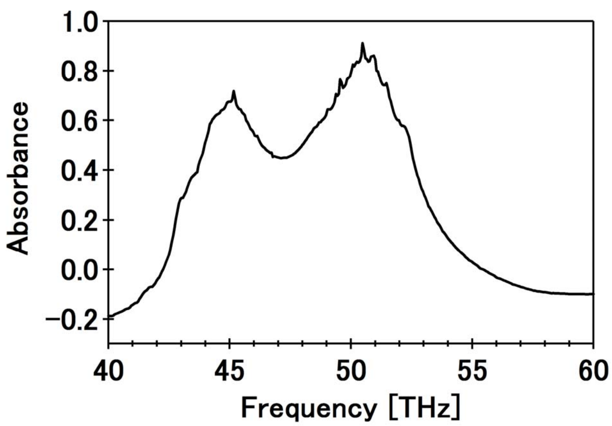

Fig 4. Absorption of TPPs structure made by the transfer printing method. It aimed at 50THz.

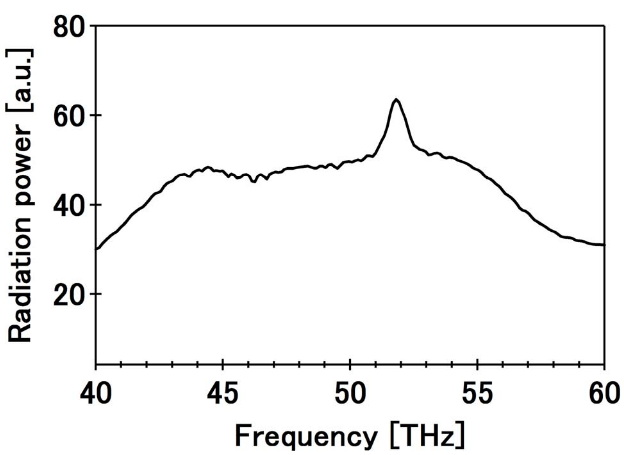

Fig 5. Radiation power of TPPs structure made by the transfer printing method. It aimed at 50THz.

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