Frequency Dispersion of Permittivity of SU-8 Resist Thin Film

Akira Kawai* and Shogo Ohtani

Department of Electrical Engineering, Nagaoka University of Technology,
1603-1, Kamitomioka, Nagaoka, Niigata, 940-2188, Japan
*E-mail: kawai@nagaokaut.ac.jp

Permittivity of a SU-8 (3050) resist film baked at 100, 150, 200 and 250°C is characterized by a typical capacitance method in the frequency range from 100Hz to 5MHz. The permittivity is relatively constant in the frequency range, but slight dependency on baking temperature can be confirmed. The dielectric loss tangent of resist film increases gradually up to 0.03 but relatively low. The typical dielectric properties of resist material can be confirmed experimentally, which indicates an application possibility of resist material as an electronic device component material.

Keywords: photoresist, SU-8, permittivity, dielectric loss, frequency response

1. Introduction

By measuring frequency characteristics of dielectric property, electrical stability of polymer material such as permittivity, current leakage have been studied. As a permanent structural material for MEMS(micro electro-mechanical systems) and μ-TAS(total analysis system), the evaluation has become important.[1,2] Some researchers have studied for fabricating a 3D structural device by employing polymeric materials in order to apply the biological application of polymer material. [3-5] Therefore, we analyze the dielectric properties of photoresist film and discuss the validity of employing as a permanent material. It is necessary lower permittivity and current leakage characteristics on the application of electronic devices.

2. Experiment

As a permanent structural material in an electronic devices, dielectric evaluation is important in order to prevent a breakdown trouble in an electric circuit. A SU-8 photoresist (3050: Kayaku Chemical Corp.) was used as a typical polymer material used in MEMS devices. Figure 1 shows a sample fabrication flow and Table 1 summarizes the SU-8 film treatment conditions. The SU-8 photoresist films were spin-coated on a copper electrode of 20mm square size with phenolic resin and then these samples were hard-baked at 100, 150, 200, and 250°C in the ambient conditions. Then, the photoresist film was partly removed. Two copper plates interpose the resist film as shown in Fig. 1. The aluminum films were connected to the end of the sample in order to form a capacitance structure for measuring.

![Fig.1 SU-8 dielectric film fabrication process.](image-url)
Table 1. SU-8 film fabrication process condition.

<table>
<thead>
<tr>
<th>Process Parameter</th>
<th>Process Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spin coat 500rpm/5sec</td>
<td>3000rpm/30sec</td>
</tr>
<tr>
<td>Pre-bake 95℃/30min in air</td>
<td>Exposure(365nm) 6.95mW/cm² for 4sec</td>
</tr>
<tr>
<td>Hard-bake Sample1: 100℃/10min 80µm thickness</td>
<td>Sample2: 150℃/10min 79µm</td>
</tr>
<tr>
<td>Sample3: 200℃/10min 72µm</td>
<td>Sample4: 250℃/10min 111µm</td>
</tr>
</tbody>
</table>

Fig. 2 Photograph of capacitor sample for permittivity measurement.

3. Results and Discussion

Permittivity $\varepsilon_r$ of resist film can be estimated by the typical formula in Eq. 1.

$$\varepsilon_r = \frac{C \cdot d}{\varepsilon_0 \cdot S}$$  \hspace{1cm} (1)

In this formula, symbol $S$ represents capacitance area, $d$ denotes resist thickness as summarized in Table 1. Photography of capacitor sample for permittivity measurement is shown in Fig. 2. The permittivity is relatively constant in the frequency range, but slight dependency on baking temperature can be confirmed, as shown in Fig. 3a. In Fig. 3b, the dielectric loss tangent of resist film increases gradually up to 0.03 but relatively low. The typical dielectric properties of resist material can be confirmed experimentally, which indicates an application possibility of resist material as an electronic device component material.

4. Conclusion

Permittivity of SU-8(3050) resist film can be estimated experimentally. Both of permittivity and dielectric loss tangent are relatively low. It can be considered that SU-8(3050) photoresist suitable candidate as a permanent material in MEMS devices.

References