내장형 capacitor를 위한 LCP와 $CaTiO_3$-$LaAlO_3$ 복합재의 유전특성

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Dielectric Properties of Liquid Crystalline Polymers and $CaTiO_3$-$LaAlO_3$ Composites for Embedded Matching Capacitors

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Abstracts

We manufactured Liquid Crystal Polymer (LCP) and (1-x)CaTiO3-xLaAlO3 (CT-LA) ceramic composites and investigated dielectric properties to use as embedded capacitor in printed circuit boards and replace LTCC substrate. The dielectric properties of these composites are varied with volume fraction of CT-LA and ratios of CT/LA. Dielectric constants are in the range of 3~15. In addition, we could get low TCC and High Q value that could not achieve in other ceramic-polymer composites. Especially, in composite with x=0.01 and 30 vol% CT-LA, the dieletric constant and Q-value are 10 and 200, respectively. And more TCC is -28~300ppm/℃ in the temperature range of -55~125℃. We think that this composites can be used high-Q substrate material like LTCC and embedded temperature compensation capacitor in printed circuit boards.

Keywords: LCP, CT-LA, embedded capacitor, LTCC

1. INTRODUCTION

Miniaturization is a great concern in every electronic equipments. In order to solve these problems, embedding of passive components is becoming an important strategies in printed circuit boards.[1]. Polymer and composite is one of the promising materials. However, polymers have high loss and large temperature coefficient of capacitance(TCC). Any deviation of TCC specifications can affect the channel/ frequency selection characteristics and high loss also affect insertion loss of filter/resonator circuits in RF module. Many researches are conducted to use LCP films[2] for embedded passives. LCP is very suitable for capacitor of filter and balun because of their low loss and frequency stable capacitance. But, in order to minimize RF module size, we need more higher dielectric constants and lower TCC. In this study, we investigated dielectric properties of LCP and composite material to obtain dielectrics which have high dielectric constants, low loss and low TCC.

2. EXPERIMENTAL PROCEDURES

To control TCC of composite, we varied the mole fraction(x) of CTLA ceramics. In this study, we make three composition of CTLA powders were suspended in a solution. The suspensions were milled for 1hr. Composites were formulated by adding different amounts of filler to the LCP suspensions. After milling for 2hrs, the mixed slurry was coated on a copper foils. To measure dielectric properties, we laminated 12um thick Cu foil onto composite film. The TCC was measured by HP 4284A LCR meter.

3. RESULTS AND DISCUSSION

Fig. 1 is the dielectric properties of LCP films in GHz range, and the TCC measurement. The capacitance of LCP films increase with measuring temperatures. The TCC range of LCP film is -450~+930ppm/K. Also, the TCC of LCP decreased from -577~+2050 to -450~+930ppm/K with frequency .

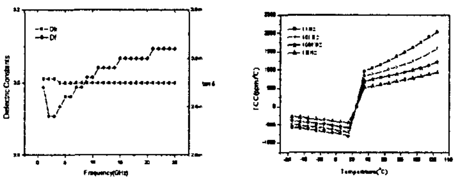


Figure 1: Dielectric properties and TCC of LCP films

Fig. 2 shows the dielectric properties of composite films. Dielectric loss was very low (0.005) at the filler content of 30 vol%at x=0.01. With Increasing fraction of low loss filler in composite, the dielectric behavior is dominated by that of ceramic filler. However, The dielectric loss of composite is not as low as expected, even if we used low loss CTLA as filler.

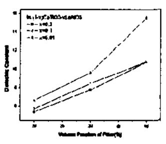
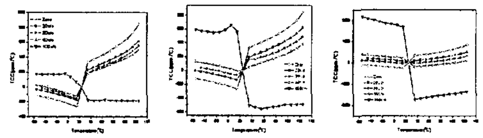


Figure 2: Dielectric constants of composite films

The TCC of composite are showed in Figure 3. For the x=0.2(Fig. 3a), the TCC decreases very slightly with increasing volume of filler. TCC range of this composite is -150~+500ppm/K at 40 vol%. At x=0.1(Fig. 3b), the TCC more decrease than that of x=0.2. Shape of TCC remain as before. TCC range of this composition is -50~+300ppm/K at 40 vol%. However, in case of x=0.01, the shape of TCC abruptly changed. As you can see from figure 3(c), TCC range of this composite is -28~+300ppm/K at 30 vol%.



(a) (b) (c)

Figure 6: The TCC of composite with volume fraction of filler (a) x=0.2, (b)x=0.1, (c)x=0.01

4. CONCLUSIONS

This paper reports the attempt to make low TCC and loss of composite dielectric for embedded RF capacitors. The TCC of the composite was significantly influenced by the TCCs of its constituents and could be controlled by combining a positive TCC resin with a negative TCC ceramics. With composite dielectric materials, depending on the fillers or matrices used, the capacitor can be easily designed to have a low or desired TCC. In conclusion, we can get composite with 10 of dielectric constant and 0.005 of loss. In addition, TCC of this composite is -28~+300ppm/K.

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