# Preparation and characterization of tactile/proximity sensor element made of CMCs/elastic resin composite

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Carbon microcoils (CMCs) have a 3D-helical-spiral structure which is similar to the double-helix structure of DNA and Meissner's corpuscle in the human skin. The CMC/silicone rubber composites (sensor elements) have a high tactile and proximity sensitivity and multifunctional characteristics due to the unique structure of CMCs. In this paper, we reported CMC sensors with multifunctional functions of tactile sensing and proximity ability examined their characteristics.

## CMC proximity sensor

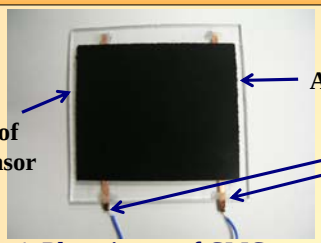


Fig. 1. Photo image of CMC sensor

**Advantage of CMC proximity sensor**

CMC proximity sensors have high tactile sensitivity.

The structure of CMC sensor is very simple.

→Only mixing CMCs with silicone rubber.

CMC sensors can be set up various location.

→spherical surface,unleveled surface etc.

## Experimental method of electrical property

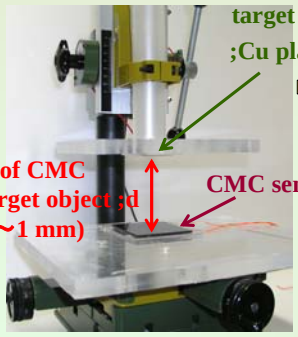


Fig. 2. Experiment to measure proximity sensing properties.

Impedance |Z|

Fig. 3. Photo image of Impedance analyzer

Frequency ; 40Hz～200kHz

## Dependence of CMC contents

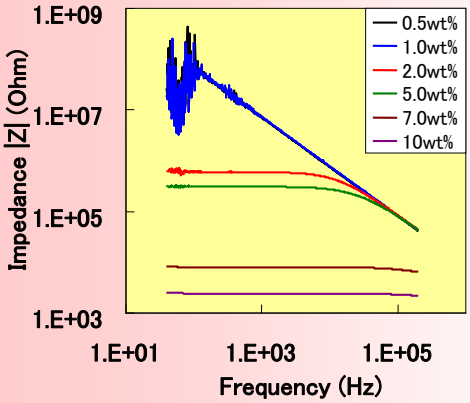


Fig. 4. The dependence of impedance |Z| on frequency as function of the CMC contents.

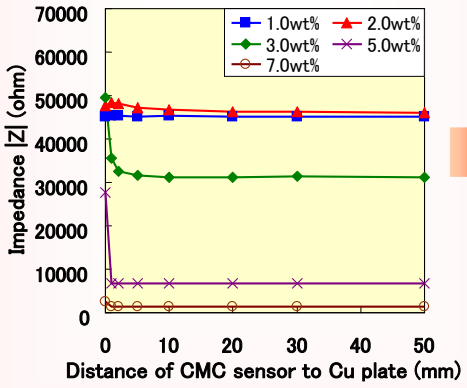


Fig. 5. Impedance |Z| at 200 kHz

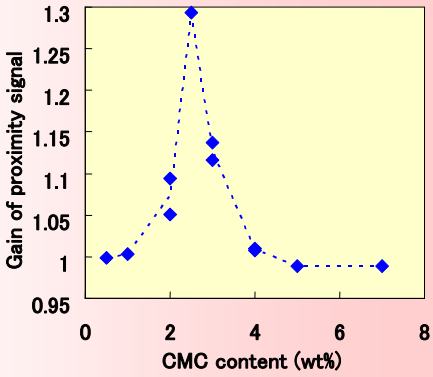


Fig. 6. The dependence of $G_p$ on CMC content

The gain of proximity signal is defined as follows:

$$G_p = \frac{|Z|_{d=1mm}}{|Z|_{d=50mm}}$$

$G_p$ ; gain of proximity signal

d ; Distance of CMC sensor to target object

## proximity sensing property of different object

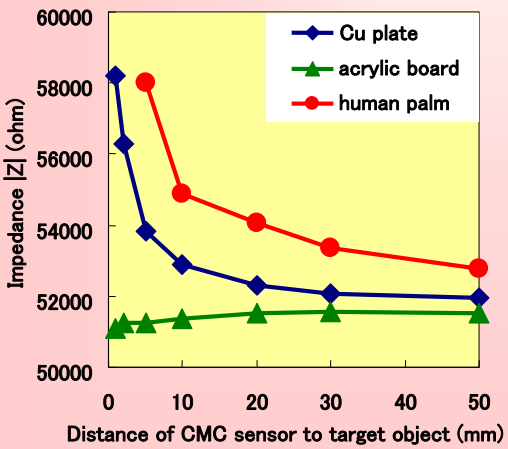


Fig. 7. Changes in impedance of CMC sensor element function of objects distance.

## Conclusion

**The dependence of CMC contents**

| CMC content | Low(~1.0wt%) | Middle(2~3wt%) | High(5wt%~) |
|---|---|---|---|
| Proximity | × | ○ | × |
| Tactile | × | △ | ○ |

Optimum CMC contents for proximity sensor ; 2.5 wt%

Gain of proximity signal ; $G_p$=1.29

**Proximity sensing property for different objects**

| Target object | Proximity signal |
|---|---|
| Cu plate | ○ |
| Acrylic board | × |
| Human palm | ○ |