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# Electrostatic Rotation of Dielectric Materials

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Sumoto[1] found the phenomena of the electrostatic rotation of a cylindrical dielectric rotor mounted between two electrodes and immersed in a weakly conducting dielectric liquid. The electrostatic rotation in a dry system was demonstrated by Klein[2] by using a glass tube-shell-rotor filled with a high dielectric constant-material such as $BaTiO_3$ and putting it between two pararell plate-electrodes with small clearance.

This paper is concerned with the phenomena of the electrostatic rotation recently found in our laboratory on the cylindrical rotors arranged between two mercury electrodes. The experimental setup is shown in Fig. 1. It is a peculiar point in this experimental system that the electrodes directly contact with the surface of a dielectric rotor.

Continuous rotation was firstly observed using a $LiNbO_3$ single crystal rotor (rotor axis//$X$-axis), 3.5 mm in diameter, at the applied voltage higher than 1 kV.

Following experimental results were obtained untill now.

1. Rotor has no prefered direction of rotation and requires some starting action for rotation.

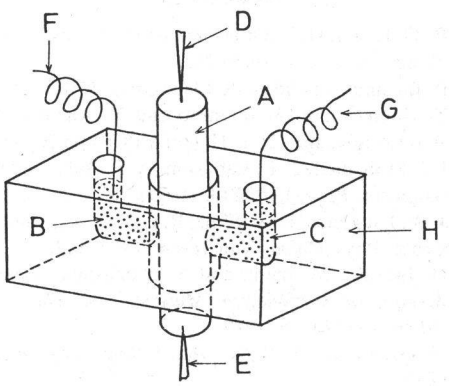


Fig. 1. Experimental setup.
A: dielectric rotor. B, C: mercury electrode. D, E: needle supporter. F, G: iron lead-wire. H: acryl polymer.

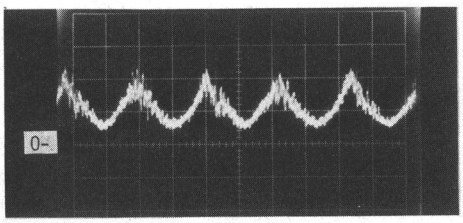


Fig. 2. Current pattern observed during the electrostatic rotation of the $LiNbO_3$ rotor in an atmosphere (R.H $=76\%$).
Applied voltage: 1 kV. Vertical scale: $1\times10^{-8}$ Amp/div. Horisontal scale: 20 msec/div.

2. Continuous rotation is somewhat difficult in dry $N_2$. When proper humidity was given to dry $N_2$, a stable electrostatic rotation was obtained at lower applied voltage (500 V).

3. While the rotor is rotating, we can observe a wavy current with a large number of spikes as shown typically in Fig. 2. The current has a maximum and a minimum at each half-rotation cycle corresponding to the $Y$- and the $Z$- face of the rotor respectively. When the rotor is stopped, however, no noticeable current is observed, differing from Sumoto's rotor.

4. Similar electrostatic rotation behaviors were observed for several rotors of fused quartz, acryl polymer, and Tefron. Higher applied voltage than 3 kV was necessary for these rotors to rotate continuously.

5. A rotor of $Pb(Mg_{1/3}Nb_{2/3})O_3$ single crystal having very high dielectric constant ($\varepsilon\approx1.5\times10^4$) compared with $LiNbO_3$ ($\varepsilon_X=\varepsilon_Y=78$, $\varepsilon_Z=32$) was also tested. However, any electrostatic rotation was not observed.

Although the mechanism of the phenomena is not clear at present stage, its key process seems to be the charge injection to the surface of the dielectric rotor from the mercury electrodes.

Further experimental studies are now in progress.

## References

1) I. Sumoto: J. Phys. Soc. Jpn. **10** (1955) 494.
2) C. F. Klein: Electronics Lett. **8** (1972) 146.