Introduction of Loop-Gap Resonator - No. 3

A Loop Gap Resonator (LGR) has the following characteristics when compared to the more generally used TE_{011} cylindrical resonator:

- High filling factor
- Different electromagnetic field distribution
- Uniform microwave magnetic field inside resonator
- Low Q-value
- Small quantity of sample (see ER100003)

Electromagnetic Field Distribution

The electromagnetic field distributions of theTE_{011}cylindrical resonator and the Loop-Gap Resonator are shown in Figs. 1 and 2. The green line in the figures shows the microwave magnetic field and the black line shows the electric field. The microwave has both electric and magnetic field elements, and dielectric loss arises from the contact of the electric field element and the dielectric material. The characteristic of the cylindrical resonator is that electric fields are distributed around the axis of resonator, and so the electric field becomes small near the outer wall. The characteristic of LGRs is that the electric fields are more concentrated in the gap, and so magnetic fields are uniformly distributed inside the loop. So, by localization of the electric field distribution, the dielectric loss becomes small. Also, as the magnetic flux is concentrated into a small space, the filling factor becomes high, and a strong microwave magnetic field (B_1) can be generated even using a low microwave power.

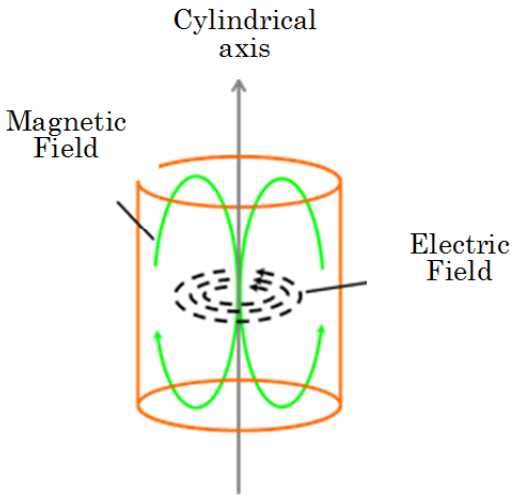

Fig.1 Electromagnetic field distribution of TE011 resonator

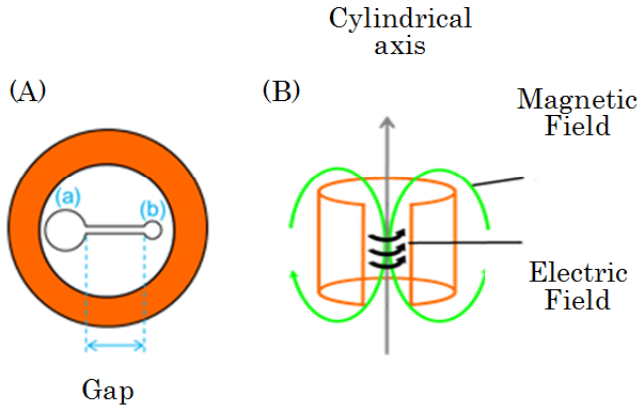

Fig.2 Electromagnetic field distribution of LGR

Microwave Magnetic Field Intensity Generated in Resonator

In this example, we compared the microwave magnetic field intensity in the two resonator types using a Power Saturation method with a fixed irradiation power and a 10^{-4}M aqueous TEMPOL solution sealed in a quartz capillary. Fig. 3 shows the ESR spectra under the same conditions, and Fig. 4 shows the result of Power Saturation. Using the Loop Gap Resonator, it is clear that the saturation curve can easily be obtained.

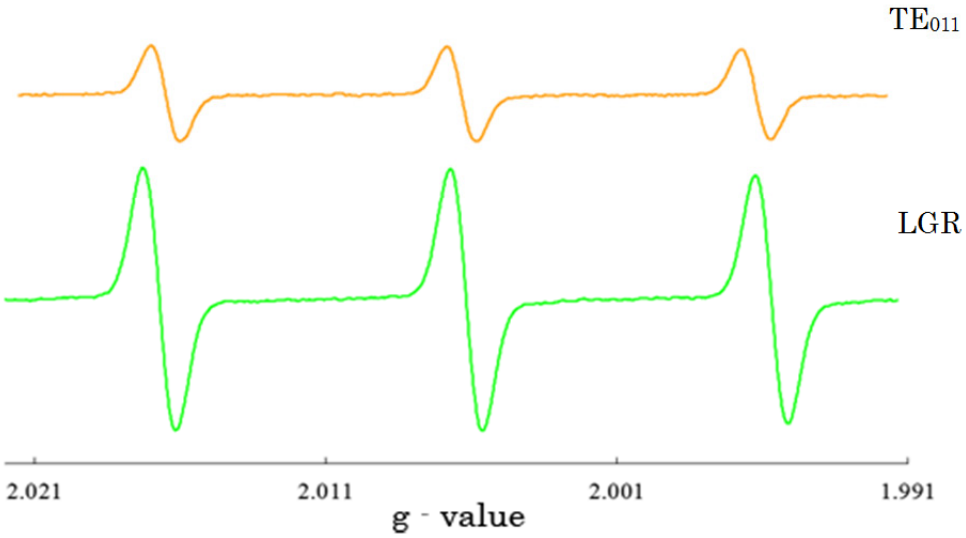

Fig. 3. ESR Spectra measured under identical conditions
TEMPOL: 10^{-4}M; Microwave Power: 0.1mW; Modulation: 0.1mT;
Sweep Time: 2min; Time Constant: 0.1s; Sample Volume: 3μl;

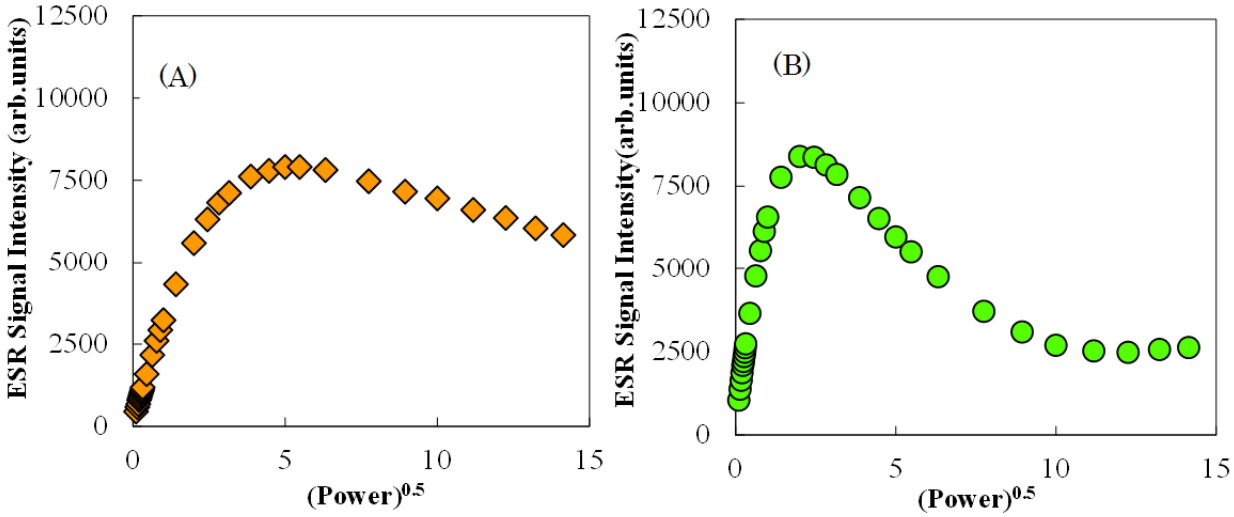

Fig. 4.Microwave Power Saturation Curve of TEMPOL Solution (10^{-4}M)
(A) TE_{011}Cylindrical Resonator (B) Loop-Gap Resonator