Possibility of Low Surface Resistance of $CuBa_2Ca_3Cu_4O_y$

S. Ohshima[a], M. Kusunoki[a], D. Okai[a] and H. Ihara[b]

[a]Yamagata University, [b]Electrotechnical Laboratory
e-mail: ohshima@eie.yz.yamagata-u.ac.jp

$CuBa_2Ca_3Cu_4O_y$ (Cu-1234) is a promising material for appreciation of microwave communication. The feature of high critical temperature (T_c) (>110 K) makes it possible to increase operation temperature of the microwave devices. Furthermore, much lower surface resistance than the conventional high T_c superconducting (HTS) materials is expected because of the low superconducting anisotropy and the long coherence length. In this project, we investigate the R_s of Cu-1234 system.

At first, exact R_s measurement method of the HTS films is required to evaluate the quality of the films. The dielectric resonator is useful and the most convenient method to obtain the R_s, because it has simple structure and does not require patterning of the films. Moreover, accurate formulae can be used for the calculation of R_s.

In order to measure exact Q_u and R_s over a wide temperature region from low temperature to the critical temperature, we investigate the optimum configuration of antenna such as distance between dielectric and antenna, height of the antenna from the plate surface and length of the loop. The circumference length of the loop (L), the height of the loop plane from the substrate surface (h), and the distance from the dielectric center to the loop center (d) were changed. It is found that the smaller loop set at a position halfway to the height of the dielectric rod brought the widest region of d in which exact measurements can be carried out. Figure 1 shows the relationship between Q_u and d of superconducting resonator for different temperatures.

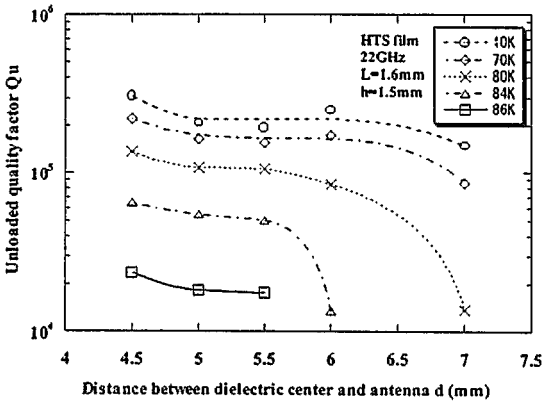

Fig.1 The relationship between Qu and d of superconducting resonator for different temperatures.

Figure 2 shows the temperature dependence on R_s of various films at 22 GHz. The R_s values of YBaCuO, DyBaCuO and TlSrCaCuO are measured. The films also prepared by variety of methods such as sputtering, co-evaporation and pulsed laser deposition. The temperature axis normalized by T_c ($t=T/T_c$). The R_s-t curves are divided into two groups according to their in-plane orientation of the films. The films in the group 1 have 45° rotated grain in the films. The other films in the group 2 are the perfectly in-plane oriented films. Each group has own residual R_s values. Taking into account that the in-plane oriented films are regarded as single crystal like films and those films show almost the same residual R_s, it is possible to consider that the values approximate the lowest limit of R_s of these materials. On the other hand, magnetic penetration depth perpendicular to the c-axis of the Cu-1234 film is 1/3 to that of conventional materials like YBaCuO shown in Fig.2. Theoretically, R_s strongly depend on the magnetic penetration depth of the film. It is expected that R_s of the Cu-1234 system is smaller than that of conventional materials.

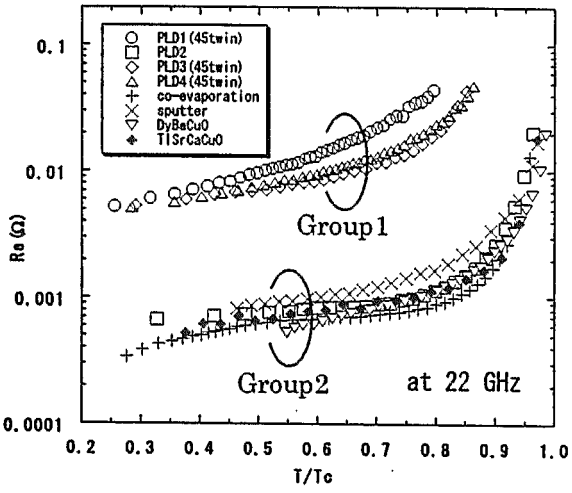

Fig.2 The temperature dependence on R_s of various films at 22 GHz