Determination of the Geometrical Factors and the Filling Factor of Superconductive Dielectric Resonators Using Computer Simulations

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Superconductor films have excellent microwave properties such as very low surface resistance (R_S) and frequency-independent penetration depth applicable for microwave devices with high performances, for which evaluation of microwave properties is essential for quality control of superconductor films. In 2004, dielectric resonator method has been published as an international standard for the R_S of superconductor films by IEC due to its non-invasiveness and high sensitivity. In determining the R_S from the dielectric resonators with superconductor films under test, the geometrical factors (G-factors) and the filling factor, which are dependent on the dielectric properties of dielectrics as well as the resonance mode and the geometrical dimensions of the resonators, should be known in advance. The G-factors and the filling factor can be calculated from the distributions of the electromagnetic (EM) fields as obtained by using Maxwell's equations without difficulty, which, however, are not easily obtained for resonators having complicated structures due to difficulties in obtaining analytic expressions for the EM fields. In this case, computer simulations provide a way to get the G-factors and the filling factor regardless of the resonator structures. The G-factors and the filling factor of sapphire resonators and rutile resonators are obtained using computer simulations, which are compared with those obtained from analytic expressions for the EM waves. Effects of the values on the measured R_S are discussed.

Keywords: dielectric resonator, geometrical factor, filling factor, microwave surface resistance