Can Dielectric Resonators Be Useful for Microwave Heating?

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The microwave dielectric resonators that we consider are multilayered structures where two or more materials with appropriate refractive indices are arranged in a given sequence. Generally, the transmissivity spectrum of such a structure exhibits forbidden bands and narrow transmission peaks. At resonance frequencies corresponding to these peaks the field localization phenomenon occurs, causing in some regions of the multilayer the field intensity to reach values significantly greater than the incident field one.

In the last years we have particularly studied the Cantor dielectric multilayers whose architecture is determined according to the triadic Cantor fractal construction scheme. The simplest Cantor multilayer structure can be realized considering the construction scheme at the second stage of growth M=2. In this case the multilayer consists of four dielectric layers of equal thickness separated by three air gaps. When inserted in a rectangular waveguide, the spectral response of a Cantor resonator can be tailored to feature a narrow transmission peaks at a given frequency in the waveguide single-mode band. This feature holds also when the resonator is perturbed by inserting an extra lossy material (load) at its midpoint. Moreover, the field can be localized just inside the load. This field localization can be very useful for applications where a high-intensity field is requested, e.g., in the case of microwave heating of low loss materials.

As an example, if we consider a Cantor resonator for M=2, realized using four layers of fused silica with relative permittivity $\varepsilon=3.78(1-j2\cdot 10^{-4})$, inserted in a WG-284 waveguide, values of the localization factor up to 7 can be obtained depending on the geometry and dielectric characteristics of the load inserted at the resonator center, where the localization factor is defined as the ratio between the maximum field amplitude in the load and the amplitude of the incident field.