Temperature coefficient reduction in layered dielectric resonators for MRI applications

F. Krauch, M. Lanagan, T. Neuberger, Q. Yang, S. Rupprecht, H. Wiesner, X. Zhu and W. Chen

Dielectric resonators have been proven to increase the RF coil transmit-receive sensitivity in magnetic resonance imaging (MRI) applications. Permittivity, temperature coefficient and dielectric loss are the main material properties that determine the characteristics of the resonators. Permittivity determines resonant frequency for a specific geometry, temperature coefficient determines how stable the permittivity (and therefore the frequency) is for a temperature range, dielectric loss determines how efficient the resonator is when transmitting energy. High permittivity materials have been found to have a significantly high temperature coefficient. Because of this, a small temperature variation alters their permittivity considerably. The Curie temperature then, is effectively the temperature at which the permittivity reaches its maximum value. Below the Curie temperature the temperature coefficient is positive, while above it, it is negative. A method is proposed that reduces the frequency variation for high permittivity dielectric resonators by using layered resonators with positive and negative temperature coefficients at the same temperature or within a desired range. For all stackings, a reduction in the resonant frequency variation is observed. On average, the frequency variation of layered resonators is 23% of the variation of single layer resonators. Further improvements may be possible by altering other parameters, like relative size of the resonators, difference in Curie temperatures and number of layers in resonators.