Photonic Crystal Microwave Resonators for Magnetic Resonance Applications

S. Greulich-Weber, A. von Rhein and E. von Rhein
Universitaet Paderborn, Department Physik, Warburger Str. 100, Paderborn, Germany.

Electron paramagnetic resonance and multiple resonance techniques like electron nuclear double resonance and optically detected magnetic resonance are powerful tools for the investigation of defects in solids. Recently high frequency sources (100 GHz) at reasonable costs became available for magnetic resonance (MR) spectroscopy providing higher spectral resolution and in principle higher sensitivity compared to lower frequencies. Usually the microwave absorption due to the MR signal is measured using a microwave bridge balanced by a microwave resonator containing the sample. At high frequencies the resonator becomes rather small which requires the development of new resonator designs. Especially for optical detection of MR optical access to the sample is needed which at high frequencies only allows the use of Fabry-Perot resonators, which provide relatively small quality factors. We show new resonator designs on the basis of photonic crystals also suitable for low frequency MR providing additional features not known from conventional resonators. These resonators are realized by defects in two-dimensional photonic crystals, in which the magnetic mode of the irradiated micowave needed for MR measurements is localized. These structures yield resonances with unusual high Q-factors. We present calculations on this kind of resonators as well as experimental results. Photonic crystal microwave resonators have numerous advantages compared to conventional resonators for MR, especially at high frequencies and for optically detected MR, such as easy application of additional modulation or high frequency fields and optical access to samples in the resonator.