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Title

Electromagnetic properties of polycrystalline diamond from 35 K to room temperature and microwave to terahertz frequencies

Source

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Abstract

Dielectric resonators are key components for many microwave and millimeter wave applications, including high-Q filters and frequency-determining elements for precision frequency synthesis. These often depend on the quality of the dielectric material. The commonly used material for building the best cryogenic microwave oscillators is sapphire. However, sapphire is becoming a limiting factor for higher frequency designs. It is, then, important to find new candidates that can fulfill the requirements for millimeter wave low noise oscillators at room and cryogenic temperatures. These clocks are used as a reference in many fields, such as modern telecommunication systems, radio astronomy (very-long-baseline interferometry), and precision measurements at the quantum limit. High resolution measurements were taken of the temperature-dependence of the electromagnetic properties of a polycrystalline diamond disk at temperatures between 35 and 330 K at microwave to submillimeter wave frequencies. The cryogenic measurements were made using a TE₀₁ dielectric mode resonator placed inside a vacuum chamber connected to a single-stage pulse-tube cryocooler. The high frequency characterization was performed at room temperature using a combination of a quasi-optical two-lens transmission setup, a Fabry-Perot cavity, and a whispering gallery mode resonator excited with waveguides. Our CVD diamond sample exhibits a decreasing loss tangent with increasing frequencies. We compare the results with well known crystals. This comparison makes it clear that polycrystalline diamond could be an important material for generating stable frequencies at millimeter waves. (31 References).