

Nanotechnology and nanomaterials

A Frequency Tunable Whispering Gallery Mode Resonator for Study of Biological Liquids

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In recent years, nanotechnology and highly sensitive materials has been increasingly used to develop the devices allowing the study of various diseases. One of promising methods for measuring the concentrations of non-labeled biological substances is the whispering gallery mode (WGM) resonator technique [1] due to high sensitivity and non-contact detection. However, an additional advantage of this technique would be the possibility resonance frequency adjustment, which has not been reported in the literature.

This work explores the application of 5CB and 1929 liquid crystals (LCs) for frequency tuning of WGM resonators targeted for accurate and sensitive analysis of bioliquids. The dielectric parameters of 5CB and 1929 LCs were measured in a wide frequency range, up to 40 GHz frequency. Dielectric constant and loss tangent are determined using special nomogram calibration procedure, plotted based on data obtained the simulation in COMSOL Multiphysics software and experiment. These data are important for understanding dielectric relaxation processes and times. The simulation process included introducing an additional absorbing dielectric layer filled with LCs and observing the changes in resonant frequencies. Since LCs have low dielectric losses, there is no significant effect on the Q-factor. However, LCs allow the resonant frequency to be effectively shifted to higher frequencies: $\Delta f_1 = 85.8343$ MHz for 5CB and $\Delta f_2 = 92.5473$ MHz for 1929 LCs located parallel to the plane of the resonator.

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1. Gubin A.I., Barannik A.A., Protsenko I.A., Chekubasheva V.A., Lavrinovich A.A., Cherpak N.T., Vitusevich S. Microwave characterization of aqueous amino acid solutions using the multifrequency WGM resonator technique // Biological Chemistry.-2023.-**404**, N 2-3.-P. 229-235.