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Knowledge of electromagnetic properties of biomolecules is essential for fundamental understanding of electric field interaction with biosystems and for development of novel biomedical diagnostic and therapeutic methods. To enable systematic analysis of the dielectric properties of biomolecule solutions we present here a method for a rational design of radiofrequency and microwave chip for quantitative dielectric sensing. We designed and fabricated the chip and experimentally demonstrated that we can extract the complex permittivity (0.5 - 40 GHz) of the water solution of alanine - one of the most common proteinogenic amino acids - without any calibration liquid and with about 20-fold smaller volume than with commercial methods. The observed dependence of extracted complex permittivity on the alanine concentration was interpreted using molecular dynamics simulations. The procedure we described here can be applied for development of dielectric sensing method of solution of any polar biomolecule or biomolecular nanostructures.

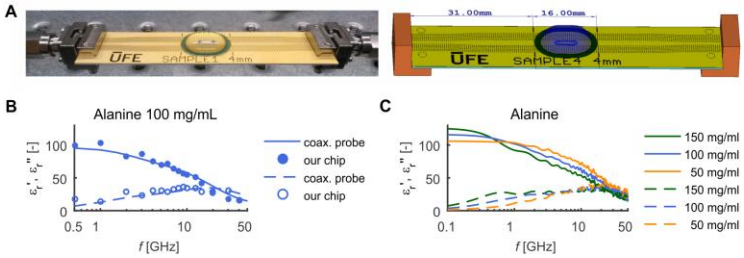

Figure 1: **A** The photo and Computer Simulation Technology model of our chip; **B** complex permittivity (100 mg/mL alanine) extracted from measurements with our chip (250 µL sample) vs. reference measurement with bulk volume commercial method (5 mL sample); **C** Real and imaginary parts of complex permittivity of alanine solutions extracted from molecular dynamics