Broadband Solvent Permittivity Measurements Utilizing Microwave Microfluidic Spectroscopy

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The complex permittivity of a material is a measure of the material's electrical properties. State-of-the-art permittivity measurement techniques have drawbacks, such as inaccuracy, narrow frequency range and loss of material integrity. The permittivity of many materials remains unknown and there is a continued demand for improved accuracy and frequency range. Microwave microfluidic spectroscopy provides accurate, nondestructive measurements of frequency-dependent permittivity of fluids. Here we used a polydimethylsiloxane (PDMS) microfluidic device assembled onto an on-chip coplanar waveguide to measure the broadband permittivity of common chemical solvents between 40 kHz and 110 GHz. We calibrated the data with microwave calibrations and fit the spectra to various functions such as Debye and Cole-Cole. We determined the validity of the fits by comparing them to the uncertainties of our measurements. With this approach, we measured several common chemical solvents, including ethanol and propylene carbonate, and here we report their frequency dependent permittivities. This non-destructive, broadband technology shows promise for the accurate measurement of the electrical properties of fluids for chemical applications.