563f Ultra-High Resolution Thermal-Wave Sensor: Applications to Water-Ethanol Mixtures

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The high-resolution measurements of thermal properties of low concentration mixtures become very relevant for environmental pollutant detection. In this study we applied the thermal-wave resonator cavity technique to the measurements of thermal diffusivity of water-ethanol mixtures at the very low end of concentrations. We used a common-mode rejection demodulation scheme, a novel subharmonic signal generation method, involving the launching of two unequal duration pulses over one modulation period. In this case, the lock-in amplifier output basically represents the difference between the response waves produced by each one of two pulses. This differential technique considerably increases an overall measurement resolution and detect relatively small signal variations induced by minute difference in the thermal properties of the sample. The measurements show resolution up to 0.2% v/v of ethanol in water, the highest ever reported using thermophysical techniques. In terms of future applications the proposed system can eventually be implemented into a self-contained in-situ liquid pollution monitor.