The 3-Omega Technique for low power gas sensing and thermal conductivity measurement  
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The 3-Omega technique is an AC measurement technique which is generally used to measure the thermal conductivity of thin films. In general, an electrical current of frequency \( \omega \) is driven through a metal heater line, causing Joule heating at a frequency \( 2\omega \). The periodic heating creates a thermal wave that penetrates the surrounding environment. The amplitude of the temperature oscillation at the source depends on the thermal properties of the environment and has frequency \( 2\omega \) but delayed in phase. This temperature oscillation then causes the resistance of the heater to oscillate at \( 2\omega \). Because the current is driven at a frequency \( \omega \) and the resistance changes at a frequency \( 2\omega \), an RMS voltage at \( 3\omega \) results. The \( 3\omega \) voltage amplitude is directly measurable and provides information on the thermal environment of the heater. Herein, we present two applications of the 3-Omega technique. First, the 3-Omega technique was applied to a microbridge heater for low power gas sensing. The sensor performance was evaluated for varying concentrations of different binary mixtures in an isothermal chamber. Secondly, the technique is used to measure the temperature dependent thermal conductivity of polymers and determine the contribution of different modes of vibration in amorphous materials.