A Microwave Oscillation Loop for Dielectric Constant Measurement

We designed and analyzed a microwave oscillation loop formed by a dielectric loaded cavity, amplifiers and transmission lines for the dielectric constant measurement of samples at both room and very high temperature. An oscillation condition for an arbitrary loop is derived in S-parameter notation, by which the commonly used oscillation condition in loop phase and gain notation is proved to be valid only in the special case when either $S_{11} = S_{2I} = 0$ or $S_{22} = S_{12} = 0$. Based on the S-parameter oscillation condition, a theoretical model is established and verified with a discrepancy of less than 0.041% between the calculated and the measured oscillation frequencies. With this model, the loop characteristics are investigated. From the measured loop oscillation frequency, the cavity resonant frequency, and thereby the dielectric constant of the sample in the cavity, can be predicted. Based on this analysis, an active dielectrometer is constructed with resultant errors of less than 4% for epsilon' <20 and less than 11% for epsilon' <80. This dielectrometer requires no tuning and no external microwave power source. Moreover, a high power (> 100W) oscillation loop for the dielectric constant measurement of a microwave heated sample (lOOO°C) is developed.

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