

Microwave Dielectric Properties of Grain in Nonequilibrium State: Effects of Moisture and Temperature

Samir Trabelsi and Stuart O. Nelson

U. S. Department of Agriculture, Agricultural Research Service,
Richard B. Russell Agricultural Research Center,
P. O. Box 5677, Athens, GA 30604-5677, U.S.A

Dielectric-based sensors for nondestructive and instantaneous determination of moisture content and bulk density in cereal grains are calibrated to predict these physical properties from measurement of the relative complex permittivity. At microwave frequencies, a temperature correction is needed, because both the dielectric constant and loss factor are temperature dependent. In many industrial processes, the grains are in nonequilibrium status or in a transient phase, making the reading of the microwave moisture meter inaccurate. In fact, any factor that triggers a change in the binding modes of water inside the kernels will translate into underestimating or overestimating the true value of moisture content.

Previous dielectric studies on cereal grain and seed showed that moisture content and temperature are interchangeable with respect to effects on the complex permittivity (Trabelsi et al., *IEEE Transactions on Instrumentation and Measurement*, **47**, 613-622, 1998; Trabelsi et al., *IEEE Transactions on Instrumentation and Measurement*, **50**, 877-881, 2001). This observation indicates that at a given frequency, data obtained for samples of different moisture contents and different temperatures fell along the same straight line when plotted in the complex plane. Consequently, the dielectric properties measured for a given moisture at high temperature are those of a virtual higher moisture content at lower temperature and vice versa. In this presentation, results of measurements at microwave frequencies on wheat samples in non-equilibrium status are reported. To investigate the effect of water in a nonequilibrium state, water was added to wheat samples and their dielectric properties were tracked at room temperature until a state of equilibrium was reached. Similarly, the temperature effect was investigated by tracking the dielectric properties of wheat samples that were cooled to -80 °C while they were warming very slowly to room temperature.