

Investigation of Dielectric Sensing for Fruit Quality Determination

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Interest in dielectric properties

- Sensing grain and seed moisture content - correlation with permittivity
- Potential use for sensing other quality factors of agricultural products
- RF and microwave dielectric heating

Relative Complex Permittivity

$$\varepsilon = \varepsilon' - j\varepsilon''$$

$$\tan \delta = \frac{\varepsilon''}{\varepsilon'}$$

ε' is the dielectric constant

ε'' is the dielectric loss factor

Melons

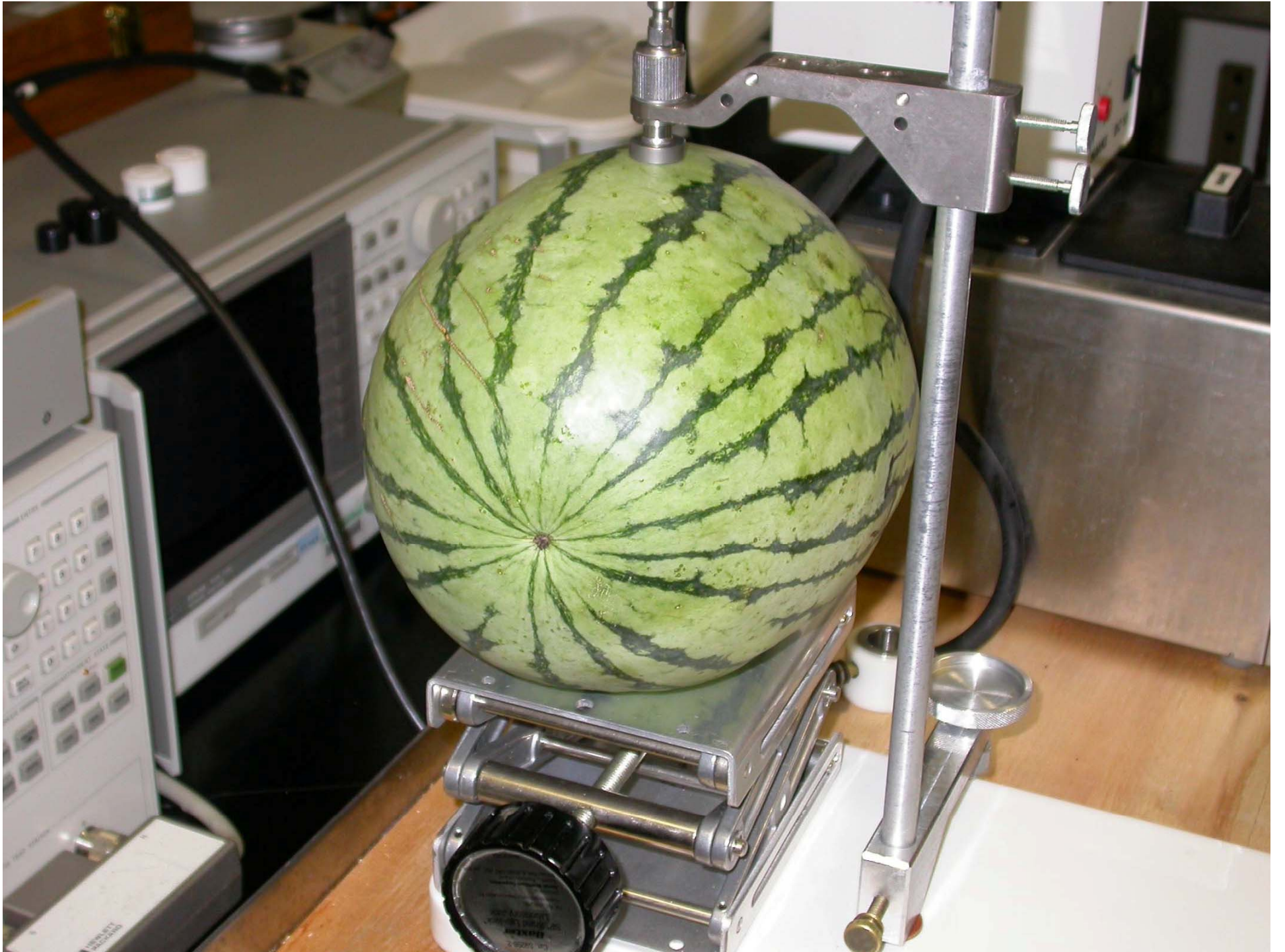
- Soluble solids content (SSC) best indicator of quality (sweetness)
- No reliable nondestructive method available for melons
- Dielectric properties investigated for correlation with SSC

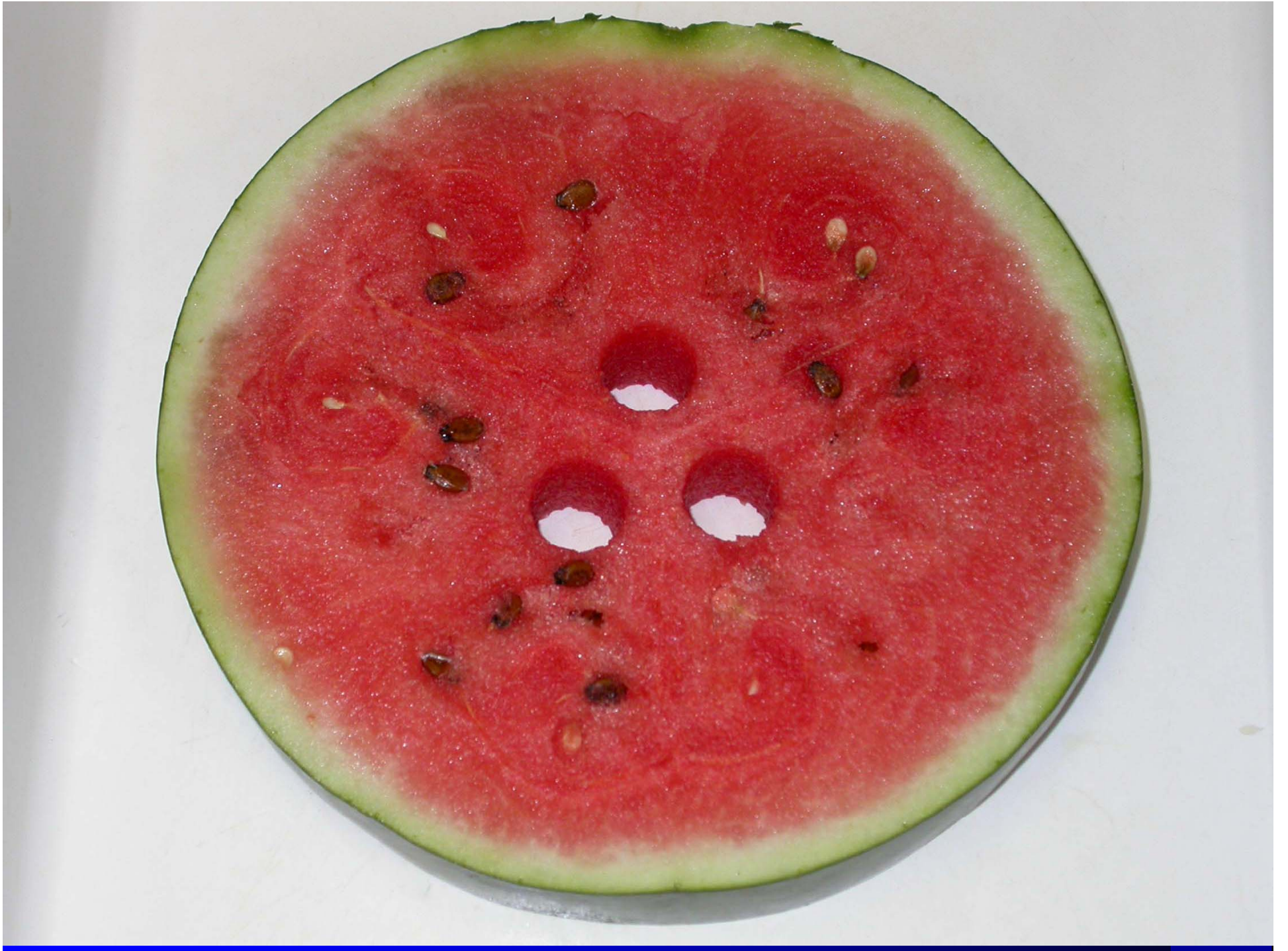
Materials & methods

- Honeydew melons and miniature watermelons grown & harvested with a range of maturities
- Both surface and interior tissue permittivity measurements made
- Cylindrical core samples cut from 44 honeydew melons and 62 watermelons for internal tissue measurements
- Dielectric properties measured from 10 MHz to 1.8 GHz – open-ended probe

Open-ended coaxial-line measurements

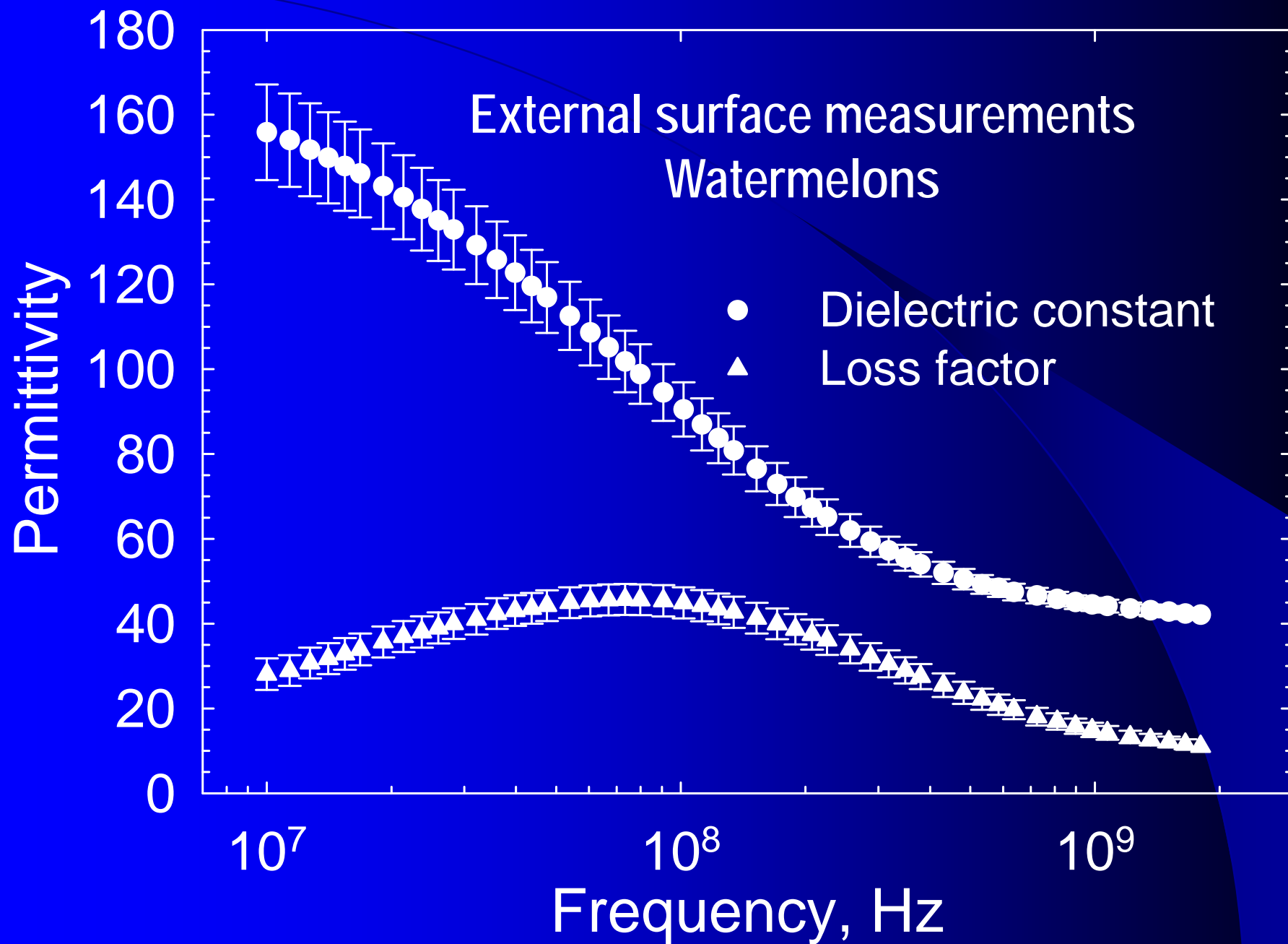
- Hewlett Packard 4291A Impedance/ Material analyzer
- Hewlett Packard 85070B probe
- Agilent Technologies 85070D software modified by Innovative Measurement Solutions for use with the 4291A

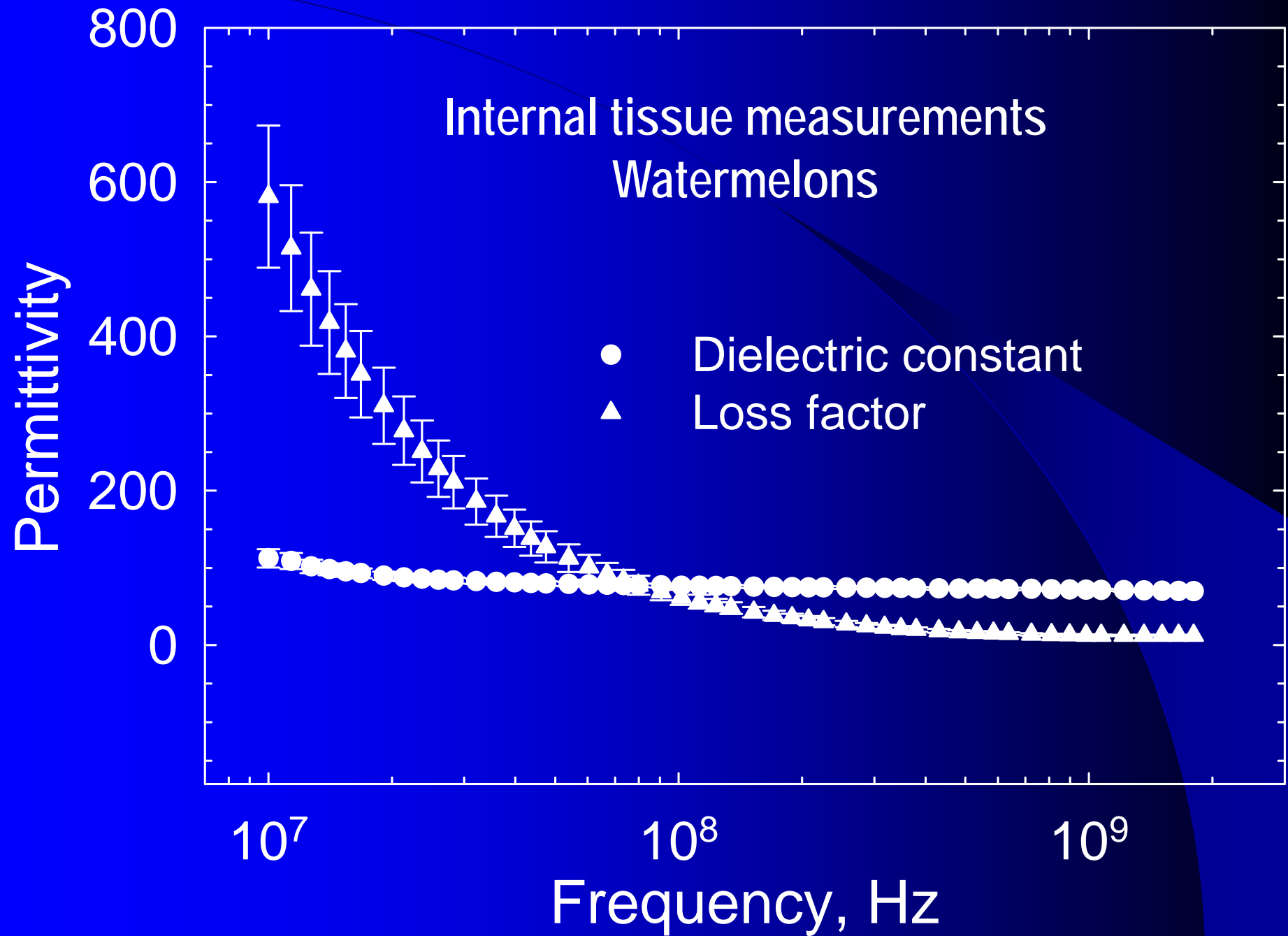


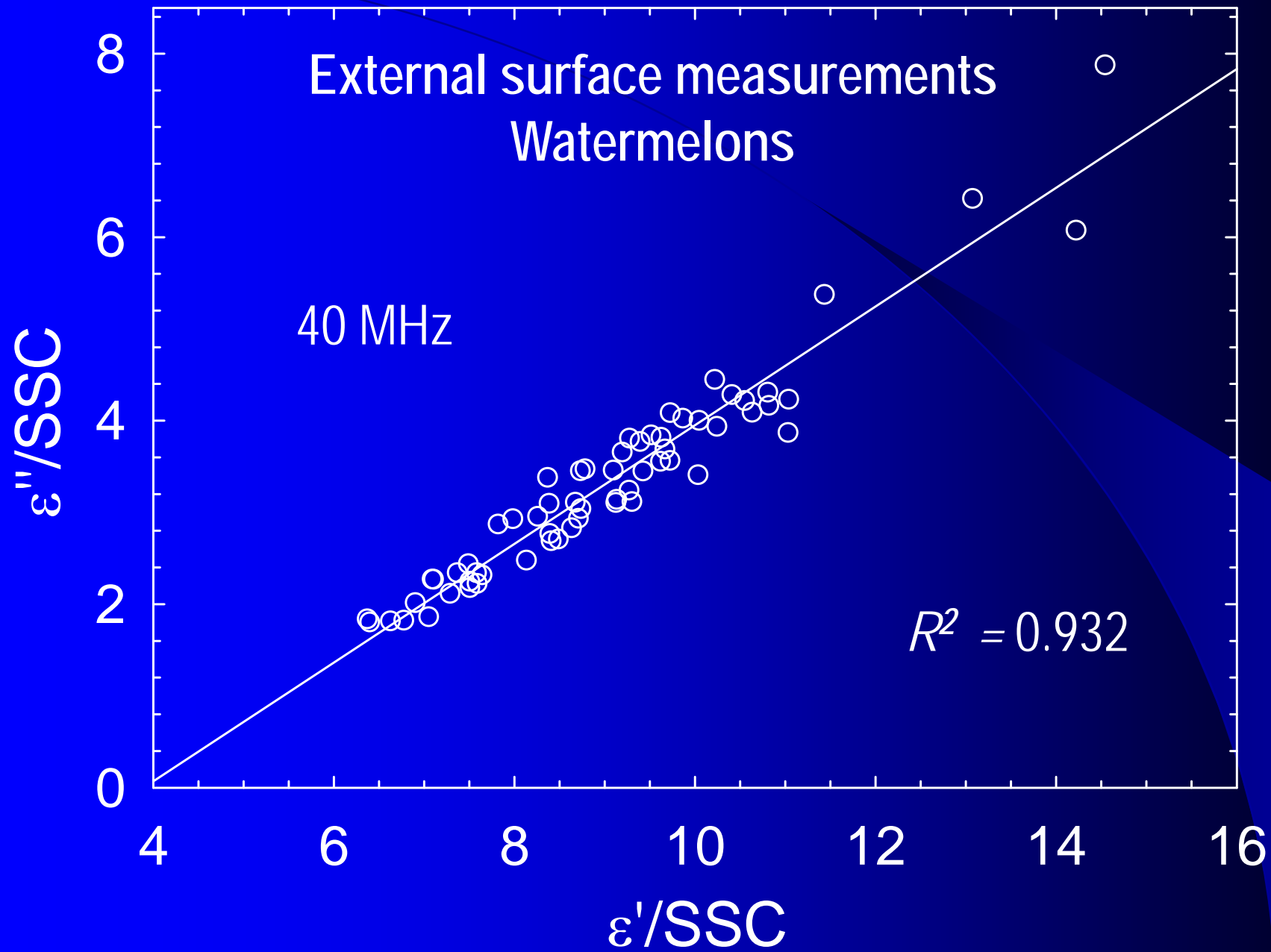


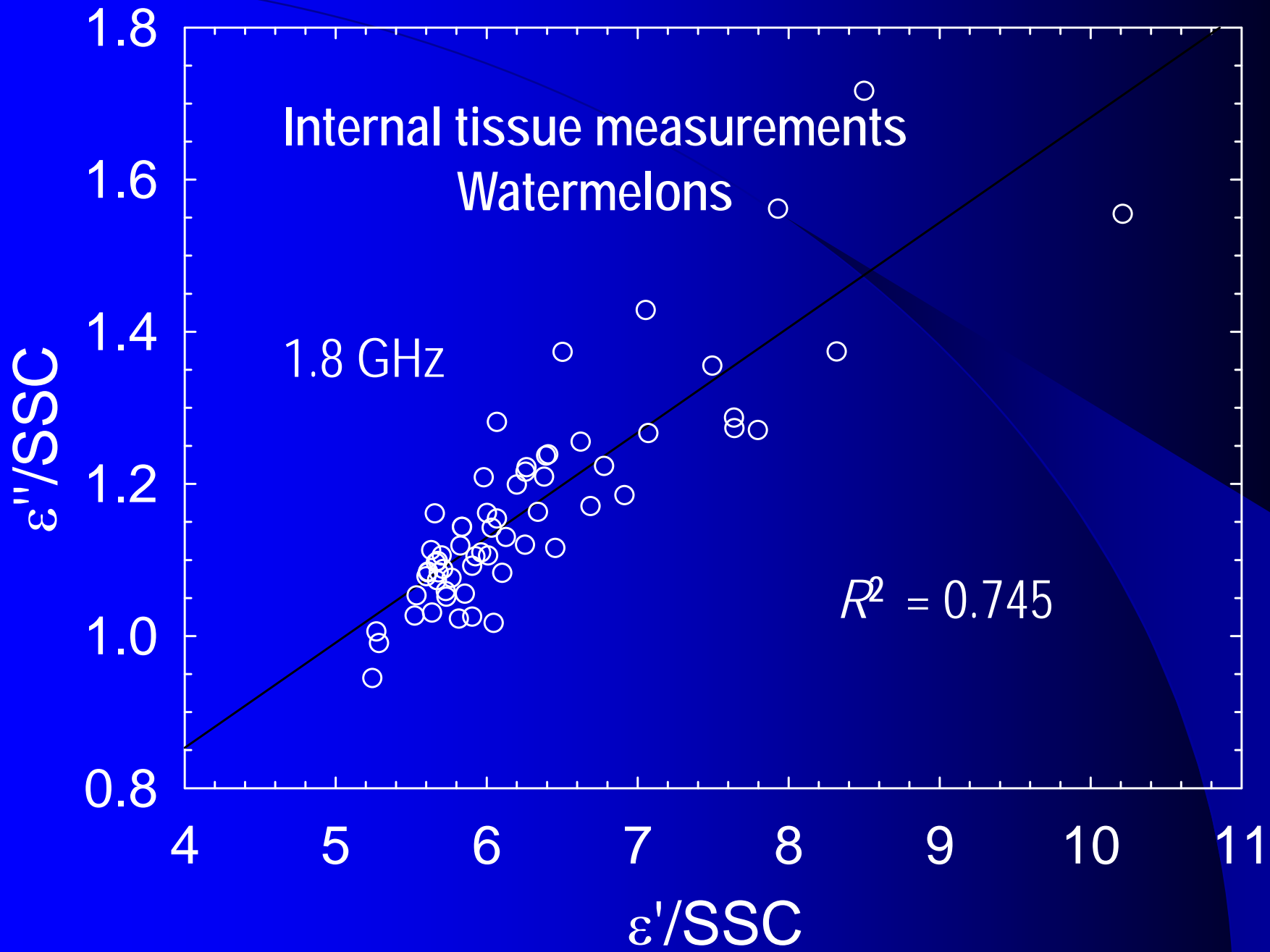


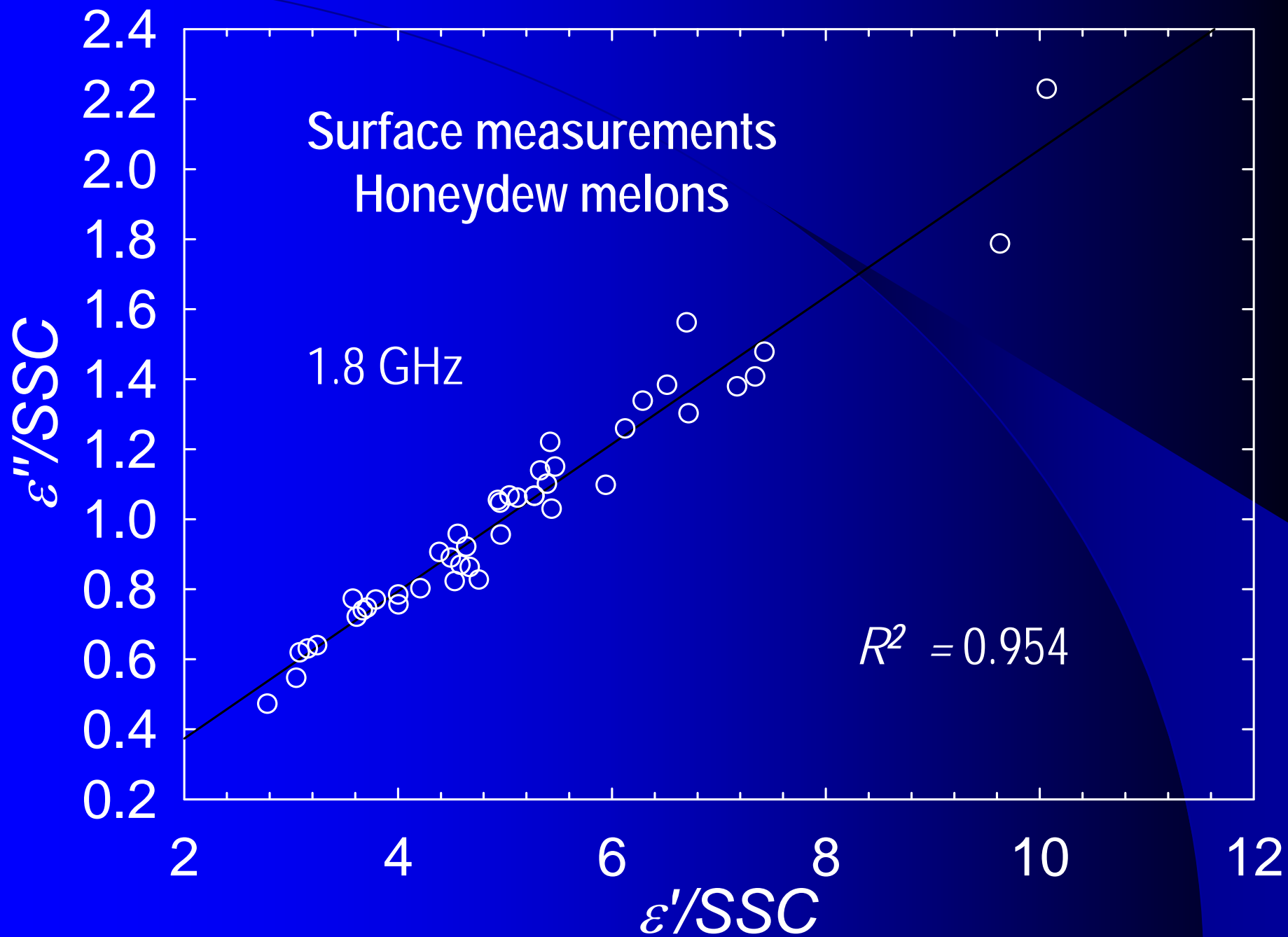


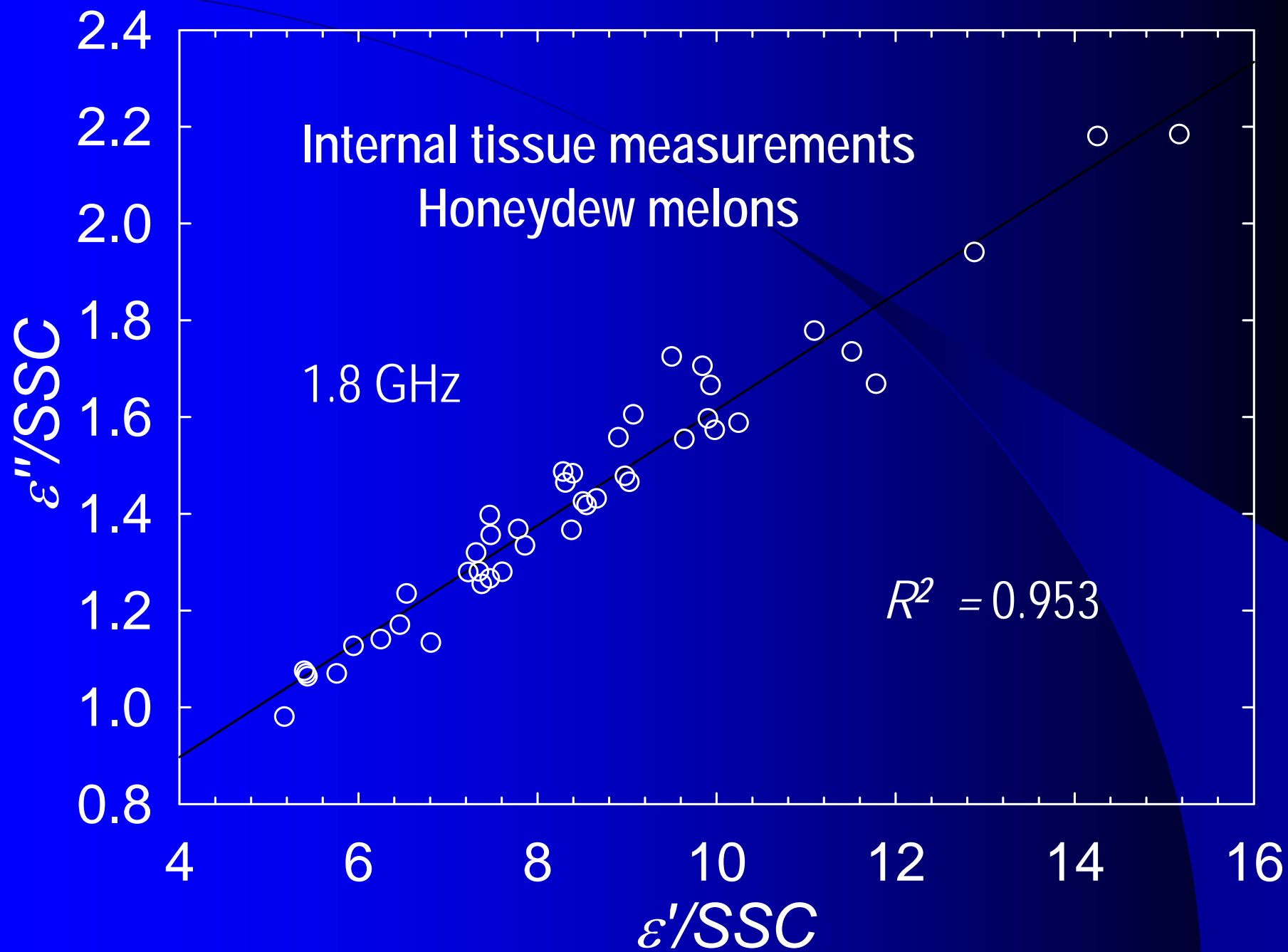












Letting s represent SSC, the equation of the line can be written as

$$\frac{\varepsilon''}{s} = a_f \left(\frac{\varepsilon'}{s} - k \right)$$

Then

$$s = \frac{a_f \varepsilon' - \varepsilon''}{a_f k}$$

provides SSC as a function of the dielectric properties only, since slope a_f and intercept k are known.

Findings

- Correlation of SSC of melons with dielectric constant is relatively low.
- Correlation of SSC with dielectric loss factor is also rather low.
- Correlation of SSC with permittivity expressed in complex-plane plot of components divided by SSC is high.
- However, this relationship did not predict SSC well from the dielectric properties

Conclusions

- Dielectric spectroscopy can yield interesting dielectric behavioral aspects of agricultural products and materials.
- Through correlation of dielectric properties with product characteristics, quality sensing is possible – moisture content is a proven example.
- New applications are expected as dielectric spectroscopy is studied further for sensing quality factors of agricultural products.

