

## APPLICATION NOTE

# Microwave Dielectrics: General Notes

Trans-Tech, Inc. (TTI) uses the term “dielectric constant” instead of the term “permittivity” which is cited in other documents. In reality, the dielectric constant is not constant. The dielectric constant varies somewhat with the blend that is used to determine a ceramic’s temperature coefficient, and it varies slightly from lot-to-lot, and changes perceptibly with temperature. TTI compensates for these effects by offering its Dielectric Resonators (DRs) sized to frequency, and provides customized temperature coefficients when necessary.

Dielectric microwave materials are commonly assigned a loss tangent to permit an estimate of signal losses. Because ceramic DRs operate at a specific frequency in a specified geometry, they allow direct measurement and specification of the Unloaded Quality Factor (Qu). The Qu is a fundamental resonator parameter that is particularly appropriate (and more useful than loss tangent) for filter and oscillator applications.

Ceramics do not:

- Age perceptibly—Any change in the resonant frequency of a DR over time can be attributed to a change in the measurement cavity or measurement technique.
- Absorb moisture noticeably—Moisture condensation on the surface of the DR can affect the Qu. The Qu can recover when the moisture is driven off, for example, by self-heating of the DR in a transmitter filter.

Because the Qu of ceramic resonators can be degraded by finger oils, pencil marking, tape, and a host of other contaminants, cleanliness is important.

Ceramics can chip easily when coming into contact with hard surfaces. Most tiny chips do not affect the electrical performance. Surface roughness is not particularly important as there are no currents in a ceramic DR, only stored energy in the form of fields. Smooth surfaces are preferable from the standpoint of avoiding trapped contaminants.

Ceramics are created in kilns at temperatures over 1000 °C. Ceramics can stand much higher temperatures than the electronic equipment they are used with, and far exceed soldering temperatures, but conduct heat much more slowly than metals. A large enough temperature gradient through a ceramic part can cause failure due to differential expansion, which is called “thermal shock.” Sudden application of heat on one side of a thick ceramic part invites fracture.

Adhesives used to mount DRs must be chosen carefully. Because adhesives always degrade a DR’s Qu, TTI has developed bonding systems to minimize Qu loss while guaranteeing bond strength. Refer to the *Adhesives for Dielectric Resonator Assemblies* Application Note (Document Number 202824), located on TTI’s website.

## APPLICATION NOTE • MICROWAVE DIELECTRICS: GENERAL NOTES

Copyright © 2013, Trans-Tech Inc., Inc. All Rights Reserved.

Information in this document is provided in connection with Trans-Tech, Inc. ("Trans-Tech"), a wholly-owned subsidiary of Skyworks Solutions, Inc. These materials, including the information contained herein, are provided by Trans-Tech as a service to its customers and may be used for informational purposes only by the customer. Trans-Tech assumes no responsibility for errors or omissions in these materials or the information contained herein. Trans-Tech may change its documentation, products, services, specifications or product descriptions at any time, without notice. Trans-Tech makes no commitment to update the materials or information and shall have no responsibility whatsoever for conflicts, incompatibilities, or other difficulties arising from any future changes.

No license, whether express, implied, by estoppel or otherwise, is granted to any intellectual property rights by this document. Trans-Tech assumes no liability for any materials, products or information provided hereunder, including the sale, distribution, reproduction or use of Trans-Tech products, information or materials, except as may be provided in Trans-Tech Terms and Conditions of Sale.

THE MATERIALS, PRODUCTS, AND INFORMATION ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR USE, MERCHANTABILITY, PERFORMANCE, QUALITY, OR NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHT; ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY DISCLAIMED. TRANS-TECH DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS, OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. TRANS-TECH SHALL NOT BE LIABLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO ANY SPECIAL, INDIRECT, INCIDENTAL, STATUTORY, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS THAT MAY RESULT FROM THE USE OF THE MATERIALS OR INFORMATION, WHETHER OR NOT THE RECIPIENT OF MATERIALS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Trans-Tech products are not intended for use in medical, lifesaving, or life-sustaining applications, or other equipment in which the failure of the Trans-Tech products could lead to personal injury, death, or physical or environmental damage. Trans-Tech customers using or selling Trans-Tech products for use in such applications do so at their own risk and agree to fully indemnify Trans-Tech for any damages resulting from such improper use or sale.

Customers are responsible for their products and applications using Trans-Tech products, which may deviate from published specifications as a result of design defects, errors, or operation of products outside of published parameters or design specifications. Customers should include design and operating safeguards to minimize these and other risks. Trans-Tech assumes no liability for applications assistance, customer product design, or damage to any equipment resulting from the use of Trans-Tech products outside of stated published specifications or parameters.