Inside *i*Coupler® Technology: Polyimide Insulation Layer

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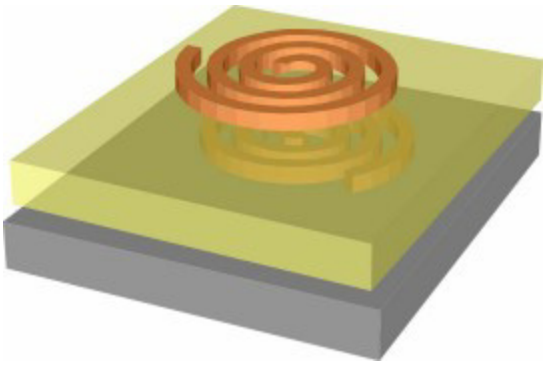

The key to *i*Coupler products' high voltage isolation performance is the 20 µm polyimide layer sandwiched between the top and bottom coils of the *i*Coupler chip-scale microtransformers. Polyimide was chosen as the insulating material for many reasons including excellent breakdown strength, thermal and mechanical stability, chemical resistance, ESD performance, and relative permittivity.

Commercial polyimide films are available in photo-resist form that are deposited on wafers with well controlled thicknesses and then easily patterned with standard photolithography processes. The polyimide is then cured to achieve high structural quality. The resulting polyimide layers used in *i*Coupler devices are 20 µm thick with a dielectric breakdown strength over 400 V/µm; this enables *i*Coupler products to survive over 8 kV instantaneous ac voltage. Because deposited polyimide films are free of voids and do not suffer from corona discharge, *i*Coupler devices also exhibit good aging behavior and work well under continuous ac voltages and dc voltages.

Besides good high voltage performance, polyimide has excellent ESD performance, capable of handling EOS and ESD events exceeding 15 kV. During energy limited ESD events, the polyimide polymer absorbs some of the charge to form stable radicals that interrupt the avalanche process and bleeds away some of the charge. Other dielectric materials such as oxide typically do not have this ESD tolerant characteristic and may go into avalanche once the ESD level exceeds the dielectric strength, even if the ESD energy is low.

The *i*Coupler polyimide also has high thermal stability; with a weight loss temperature over 500°C and a glass transition temperature of about 260°C. The polyimide also has high mechanical stability with a tensile strength over 120MPa and a high elastic elongation over 30%. In spite of its high elongation, polyimide does not deform easily, because the Young's Modulus is about 3.3Gpa.

The polyimide has excellent chemical resistance which is one reason it has been widely used for insulation coatings for high voltage cables. High chemical resistance also helps to facilitate IC processing on top of polyimide layers, such as the Au plating used to create *i*Coupler transformer coils.

Lastly, the thick polyimide layers, with a dielectric constant of 3.3, work well with the small diameter Au transformer coils to minimize capacitance across the isolation barrier. Most *i*Coupler products exhibit less than 2.5 pF capacitance between input and output.

Because of these characteristics, polyimide is increasingly used in microelectronics applications, and it is an excellent choice as insulating material for the *i*Coupler high voltage digital isolators.

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