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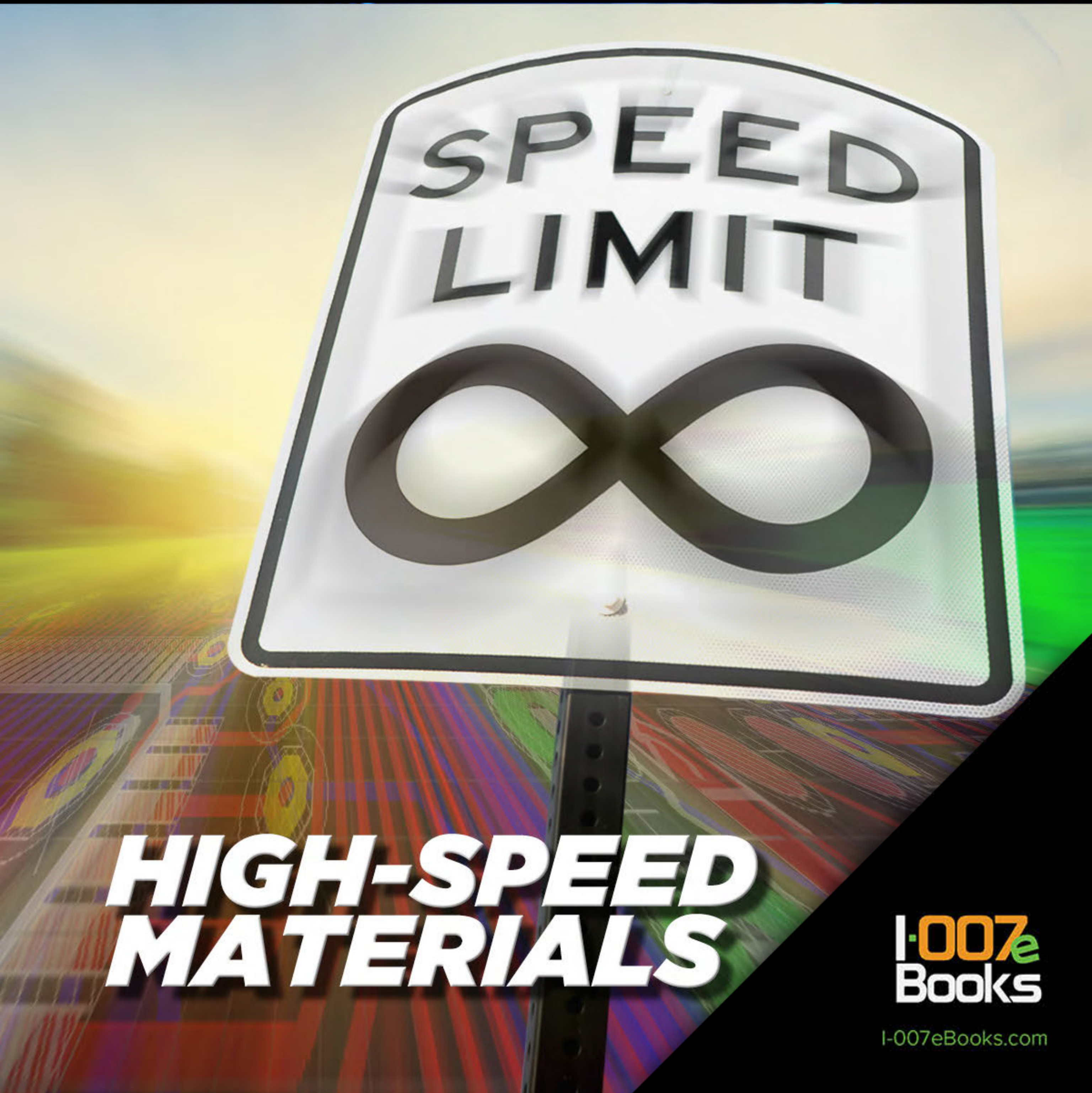
Fabricators Speak Out on High-Speed Materials p.12

TTM Shines a Light on Optical Interconnect p.22

Bruce Mahler Discusses Ohmega's Resistive Material Technology p.32

Much More!



HIGH-SPEED MATERIALS

Woven Glass Weave Effect: Electrical Concerns and Remedies

by John Coonrod
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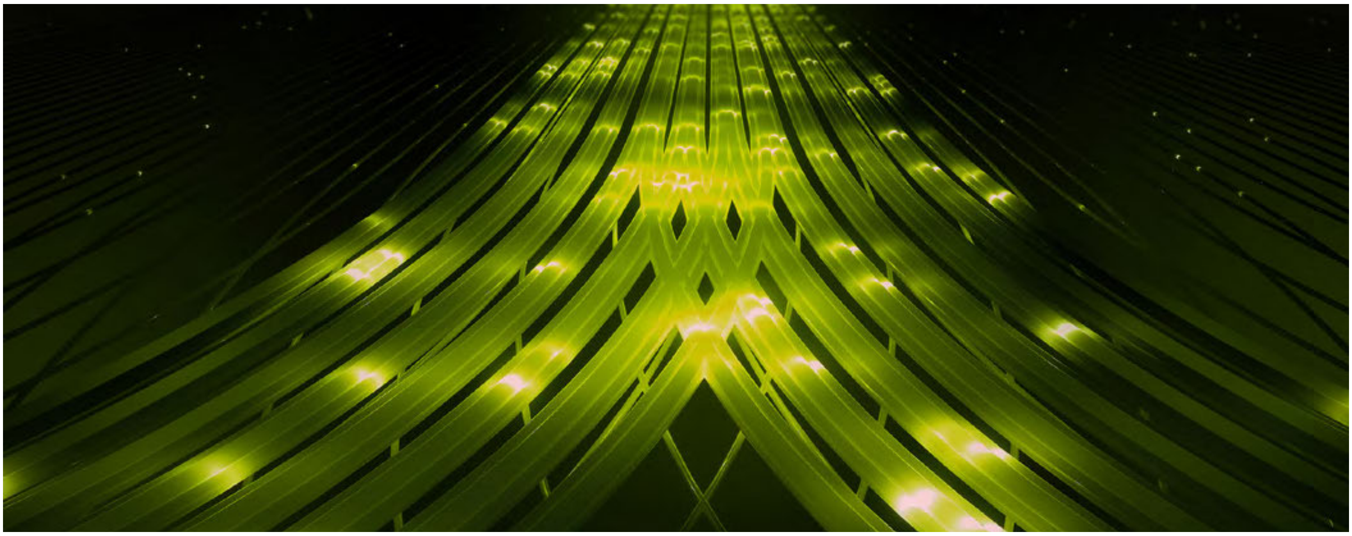
The idea of glass weave effect has been around for many years, and it is a topic that is somewhat controversial. In theory, the glass weave effect is a concern that the structure of the glass fabric can have a negative influence on high-frequency or high-speed digital circuit performance.

Most woven glass fabric used to improve mechanical properties of laminates has areas of glass bundles and open areas between the bundles. The glass bundles' dielectric constant (Dk) is typically about 6 and the areas between the bundles can have a Dk of around 3, depending on the resin system used to make the laminate. One concern for the glass weave effect is that if a critical circuit conductor is perfectly aligned to the pattern of bundles and open areas, the conductor will experience different Dk in small isolated areas. It is possible at very high frequencies or extremely high speed digital rates, that these isolated Dk differences could have an influence on the circuit performance.

One example of the glass weave effect: A microstrip transmission line circuit (two copper-layer circuit) uses a laminate with a Dk of 3.0. At 77 GHz, the ¼ wavelength will be about 0.024" and the 1/8 wavelength approximately 0.012". Theoretically, it is known that when an electromagnetic wave is propagating in a medium and encounters an anomaly that is ¼ wavelength or larger, the wave can be disturbed and possible resonances can occur. Additionally, real-world experience has shown that anomalies in the medium which are ¼ wavelength can cause wave propagation issues. If a laminate has a glass style with openings or bundle sizes which are 1/8 wavelength or larger, the discrete Dk anomalies of the glass bundles and open areas could cause circuit performance issues. Many different glass styles are used in the industry, and several glass styles have dimensions of 0.012" (1/8 wavelength at 77 GHz) or larger.

If the laminate is using two or more layers of woven-glass fiber, this may lessen the concern for glass weave effect in this example. When two layers of glass fabric are used to make the laminate, the odds of the bundles or open areas aligning is very unlikely. This means the discrete Dk anomalies due to the glass bundle and open areas will be greatly lessened and the impact on the wave could be minimal or insignificant.



There are other concerns with glass weave effect. To keep the explanation simple, it will be assumed that the laminate has one glass weave layer and that the circuit is a simple microstrip transmission line. Glass weave effect is often a concern where PCBs are used in large volume and potentially causing a circuit-to-circuit performance difference. A basic way to conceptualize the issue is to assume that most circuits will have a critical conductor randomly aligned to the glass weave pattern and the wave associated with that conductor is experiencing an averaging effect of the glass bundles and open areas. Then, in perhaps one circuit out of 100, the critical conductor is aligned perfectly, directly on top of an area of glass bundles and the wave will experience a higher Dk than the previously mentioned circuits. The higher Dk brings multiple effects: The impedance can be lower, the phase angle shifted, and the wave velocity slowed, all of which can impact the circuit performance.

A different concern for glass weave effect is the issue of circuits which have coupled features or use differential pair technology. When a pair of conductors in a circuit design has a well-defined relationship, each conductor must have the same wave propagation medium. If one conductor of the pair has a different medium, the coupled pair will not perform as expected by the designer. In RF applications, coupled conductors are used in filter and directional coupler designs. In high-speed digital application, coupled conductors are used in differential pair designs. For RF applications, if one conductor experiences a different Dk than its pair, the phase angle between the pairs will not be as designed and a shift in performance can occur. The high-speed digital application often has timing issues where the signals from each conductor of the pair will need to arrive at a point in the circuit at the same time. When the signals arrive at different times, that is knows as skew, which may be due to glass weave effect slowing the wave velocity of one conductor more than the other. Skew can be very problematic with very high-speed digital circuitry.

Many laminates formulated for high-frequency applications avoid issues with glass weave effect by utilizing a filled resin system. In that case, the open areas between the glass bundles do not have an abrupt difference in Dk from the glass bundles, as is the case with an unfilled resin system. The filler is typically a different Dk value than the resin system, which is also different than the glass bundles. The added filler helps to average the Dk differences in the isolated areas, and there is less of a discrete Dk difference between the glass bundles and open areas. Finally, some high-frequency laminates have no woven glass fabric; these materials are often used at millimeter-wave frequencies.

Don't forget that it is always a good idea to contact your materials supplier if you have questions about glass weave effect. **PCBDESIGN**

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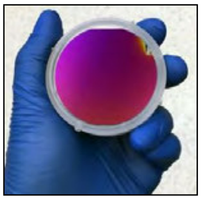
Low-Cost 'Solar Absorber' Promising for Future Power Plants

Researchers have shown how to modify commercially available silicon wafers into a structure that efficiently absorbs solar energy and withstands the high temperatures needed for "concentrated solar power" plants that might run up to 24 hours a day.

The research advances global efforts to design hybrid systems that combine solar photovoltaic cells, which convert visible and ultraviolet light into electricity.



"The key point is that to capture sunlight as efficiently as possible you have to do two things that compete with each other: one is to absorb as much power from the sun as possible, but secondly, not reradiate that power," said Peter Bermel, an assistant professor in Purdue University's School of Electrical and Computer Engineering.