When Comparing Data Sheets, the Devil is in the Details

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Many PCB fabricators and designers will often compare the properties listed on material data sheets to assist with the material selection process. Of course, this is a wise thing to do when choosing materials, however data sheets need to be reviewed carefully. Comparing information between data sheets may be misleading since there are many variables that go into collecting the data.

One major issue with understanding the information on data sheets and making appropriate comparisons is the test method category. It is possible to test the same piece of material for dielectric constant (Dk) using two different test methods, and arrive at two different—but correct—answers. Most PCB materials are anisotropic, which means the Dk is not the same on the x-, y- and z-axis, where the z-axis is the thickness of the material. Some test methods will test only the z-axis and other test methods will test the x-y plane. So it is possible to test the same piece of material, using a test method that evaluates the z-axis of the material for Dk, and get a different answer when testing that same material using a procedure that tests the x-y plane of the material. Both answers could be correct, but this can cause confusion when comparing data sheets. It is very important to ensure the test methods are the same when comparing similar materials.

Electrical properties can be misleading since the Dk and dissipation factor (Df) of all circuit materials is frequency-dependent. These properties will naturally change with a change in frequency. Again, when comparing data sheets from similar materials and ensuring the test methods are the same, the subtle fact that the test frequency is different can alter the com-
comparison. All materials will have a lower (better) Df at lower frequencies, and if a comparison is done with material A at 2.5 GHz and material B was tested at 10 GHz, then it is not an equal comparison because the lower-frequency test will naturally have a lower Df when compared to testing that same material at a higher frequency.

Peel strength or bond strength is another property that is often misunderstood. In my years with flex circuit engineering, I found it interesting that the material of choice for one of the most demanding flex circuit applications had very low bond strength. The read-write flex circuit inside a traditional mechanical hard disk drive had to survive hundreds of millions of flex cycles, yet the material of choice had a bond strength of typically about 1.5 pli (pounds per linear inch). That is considered very poor for bond strength, yet the circuit had excellent long-term performance inside hard disk drives (HDDs). That is because when the circuit is designed correctly and the application is optimized, many times bond strength is not critical. Bond strength becomes more critical when the circuit has mechanical and/or thermal stresses applied. In the case of thermal stresses or thermal cycling, bond strength may not be a major concern if the material has well matched CTE to copper and the other substrates that make up the circuit.

Another interesting point about bond strength is that the value is dependent on specific mechanical properties at the breakpoint where the copper is being peeled away from the substrate during the peel strength testing. The same material which had poor bond strength and was used in HDD, would have very good bond strength numbers if it was undercured. Of course, there are other properties, like surviving solder float, which would be negatively affected but an under-cured adhesive system will often have higher peel strength during bond testing. The reason is the undercured adhesive is more elastic and stretches at the breakpoint during the peel strength testing. Basically, there is more material hanging on at the breakpoint between the copper and substrate during peel strength testing, and that causes the bond values to increase. The undercured adhesive should not be used in applications, but if a person were to look at bond values only, it could be deceiving. This same thought process should be used when comparing materials that have different formulations.

As a general statement, thermoplastic materials are soft and stretchy, which causes them to report a higher bond strength number than many thermoset materials which are rigid and have a clean breakpoint during bond testing. The bottom line summary for bond strength is that a material with high bond strength is not necessarily better than a material with low bond strength. Bond strength should only be one aspect of material selection and if the material has good CTE and the application does not stress the bond-line of the copper-substrate interface, bond strength may not be a major consideration.

Moisture absorption is another property where the results are often confused on the data sheets. There are many ways to test materials for moisture absorption. One method, which is probably a worst-case scenario, is etching all the copper off the laminate, weighing the substrate, submerging it in hot water (50°C) for 48 hours, weighing it again and the weight difference gives the percentage of moisture absorbed. Obviously, most PCBs are not submerged in water, therefore, comparisons using this test method should be thought of as a reference between materials only. Since there are many test methods for moisture absorption, data sheet comparisons may be confusing if one data sheet.
is reporting moisture absorption from 24-hour testing, at 25°C at 85% RH and the other data sheet is using the 48 hr./50°C/water submersion test method. These comparisons should not be done since the two testing conditions are not the same.

Some test methods for thermal conductivity will test the raw substrate only and other test methods will include the copper of the laminate with the substrate testing. Since copper has a thermal conductivity of about 400 W/m/K, the added influence of copper will certainly improve the thermal conductivity values for a test method which includes that metal. And if the test method includes copper, the substrate thickness during testing is important since a thinner sample will be more dominated by the copper influence.

I have pointed out a few things to consider when comparing data sheets, but there are many more. Just about every property on the data sheet has its own story. To do a fair comparison between data sheet properties, one must consider how they are tested, conditions and the details must be well understood. It is highly recommended that you consult your material suppliers when reviewing information given on any data sheet. PCBDESIGN

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### Microelectronics R&D Intensifies to Address High Customer Demand

Governments and industry stakeholders are keenly following developments in the microelectronics industry, as these technologies could potentially disrupt and bolster the Internet of Things (IoT) megatrend. Microelectronics will support eco-friendliness, Innovating to Zero, smart and connected homes, cloud computing and miniaturization trends, and influence the technological progress of a wide range of industries. This will open up opportunities across value chains, and key industry participants are actively entering this technology space to gain an early mover advantage.

“One of the major selling points of microelectronics is its low power consumption. Industries recognize that the technology’s rapid charging, smart antenna, wireless charging, and organic light-emitting diodes (OLEDs) make it extremely cost effective in the long term,” noted Frost & Sullivan TechVision Research Analyst Brinda Manivannan.

Top Technologies in Microelectronics, 2017 is part of Frost & Sullivan’s TechVision (Microelectronics) Growth Partnership Service programme. The study assesses the impact of the top emerging microelectronics technologies, the innovation strength of each region, and the global market potential of the technology. It also covers the dynamic technologies that enable the convergence of megatrends such as smart cities, vehicle to X (V2X) systems, IoT, and connected systems.

While the benefits of microelectronics are manifold, scientists and adopters are still challenged by the huge cost of research and development (R&D), capital-intensive manufacturing, scalability limitations, volume production and lack of a structured supply chain. However, technology developers are gradually addressing these roadblocks to adoption, with North America leading in technology advancements and Asia-Pacific in technology adoption.

“Microelectronics R&D will also get a boost with the impending bandwidth crunch due to the increased penetration of augmented reality and virtual reality devices. Microelectronics can be employed to develop faster data transmission technologies such as visible light communication (VLC) and advanced data storage techniques to power data-intensive applications,” noted Manivannan.