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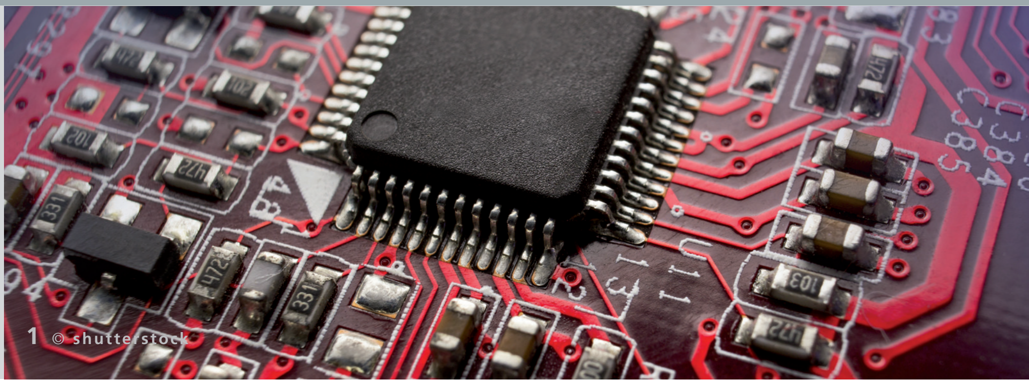

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1 *ORMOCER®s as passivation and packaging material for conventional and highly integrated PCBs*

DIELECTRIC ORMOCER®S

FOR SYSTEM-IN-PACKAGE ELECTRONICS AND HIGHLY INTEGRATED SYSTEMS

Motivation

The miniaturization of electronic devices leads to higher integration densities. This holds for 3D integration as described for system-in-package (SiP) approaches but also for highly integrated 2D solutions such as conventional MCMs etc. The higher integration requires dielectric and passivation materials which possess low-k values in order to reduce parasitic capacities and prevent cross-talking between different conductors. This is even more crucial if circuits are operated at high frequencies. Further, due to demands by production processes and operation, it is searched for materials which offer a high thermal stability but can be processed as easily as conventional polymeric packaging materials. In the best case, materials also provide an enhanced thermal conductivity since the heating of devices by operation is more pronounced the higher the integration density is.

Beside their economic and technical advantages, higher integrated devices are in focus for many applications which rely on the form factor to take up a minimum of space. Such applications include mobile or control devices which must be able to withstand special environmental factors, e. g. mechanical stress, harmful gases or condensation through humidity. Here, materials are required to show superior stability over conventional thin film encapsulation.

The material processing should be compatible to cost-effective techniques widely spread in electronic industries.

Solution

ORMOCER®s – inorganic-organic hybrid polymers – offer the solution as they can meet all the requirements listed above. The material properties of ORMOCER®s for dielectric applications can be selectively adjusted through a controlled synthesis as synthesis parameters (educts, stoichiometry, catalysts, reaction conditions) play a key role in the formation of inorganic and organic networks and so, in consequence, of the resulting material properties.

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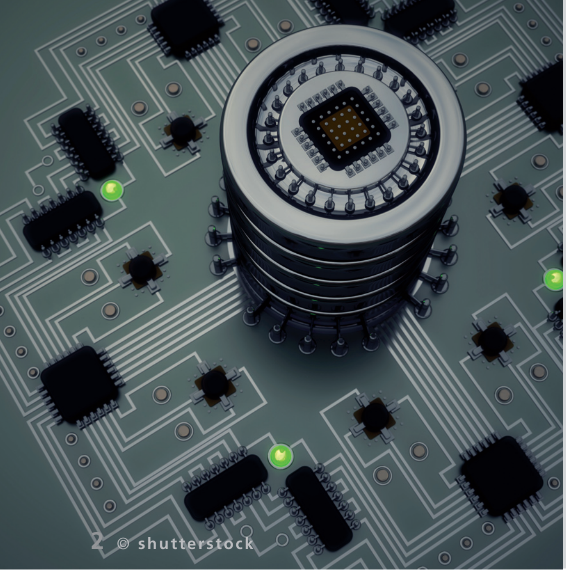
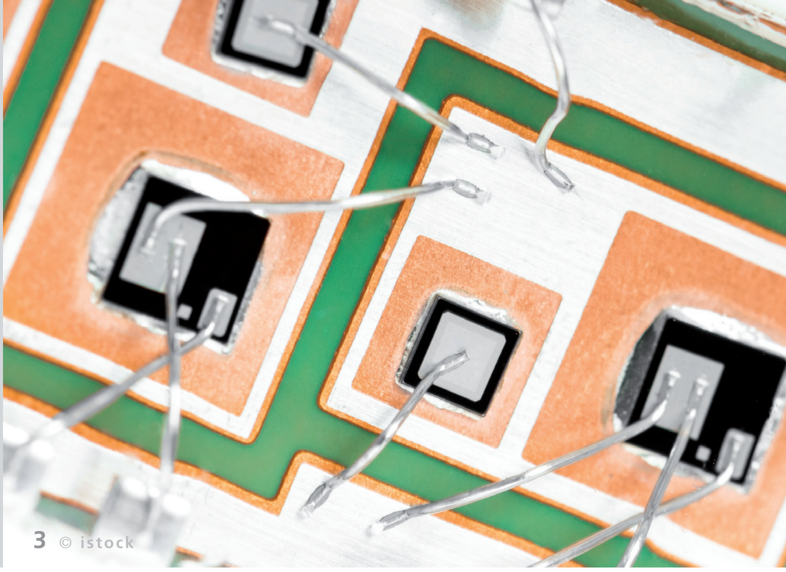




Over the past two decades, Fraunhofer ISC has gained a lot of experience in controlling the chemistry of hybrid polymers and in the fine-tuning of material properties to individual requirements and intended applications. Patternable dielectric ORMOCER®s can be synthesized for electronics and electro-optical applications. Process parameters are identified in order to ensure that material processing can be integrated in production lines for conventional multi-chip modules (Figure 4), 3D stacked patch antenna as well as for highly integrated printed circuit boards. Since even mechanical values, such as Youngs Modulus, can be adjusted ORMOCER® dielectrics can also be used for flexible electronic applications and flex-rigid PCBs. Micro patterned ORMOCER®s can be made by photolithography, UV replication, printing and dispens techniques, laser ablation, and two-photon-absorption polymerization. The most outstanding feature of ORMOCER® materials is the high thermal stability (> 300 °C) although curing temperatures are moderate (80 °C – 170 °C). While the first property is advantageous for high power electronics, subsequent processing of sophisticated materials and challenging operating environments, the latter property is useful for devices which use thermally sensitive components. The very good adhesion properties of ORMOCER®s on various substrates, particularly on metals, glass substrates and SiO_2, help reduce process steps such as substrate pre-treatments. Other beneficial properties include low water uptake and water vapor permeability. ORMOCER® materials provide high specific resistance ρ and low permittivities (ε_r: 2.5 @ 100 kHz). For high frequency applications the dielectric loss (tan δ) of ORMOCER®s can be minimized.

ORMOCER®s can be formulated as soluble or solvent-free materials (depending on the respective process requirements). Due to the chemical cross-link, the materials show low or none outgassing and are suitable for use in subsequent vacuum processes. Shrinkage and CTE can be influenced by selection of cross-linkable groups. In addition, ORMOCER®s provide excellent optical properties and can also be used in optical 3D technology for data transfer.

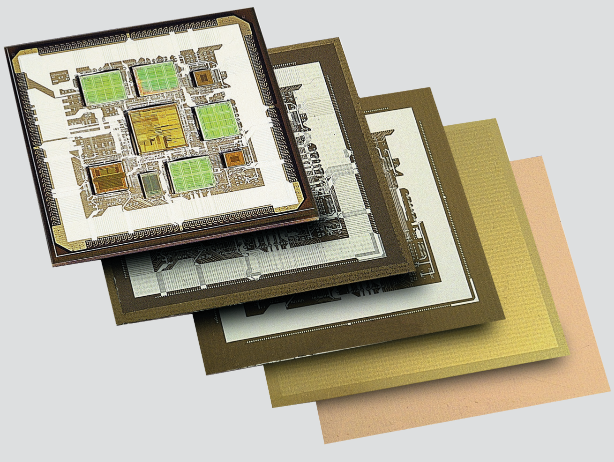
Future development

Fraunhofer ISC looks forward to optimizing ORMOCER® dielectrics to the special property profiles required by future technologies and in cooperation with customers and R&D partners. One aim of current activities is the further increase of thermal stability to even higher temperatures through optimized ORMOCER® concepts or novel chemical approaches. Further topics can be discussed with Fraunhofer ISC researchers.

2|3 Higher integration (3D) and power electronics demands for sophisticated dielectric and packaging materials

Adhesion (DIN 53151)		
Al_2O_3-ceramic	0 – 1	(0 = very good)
Copper	0 – 1	
Aluminium	0 – 1	

Electrical properties	
Permittivity ε_r	2.5 ...4 (in the range GHz-Hz)
Dielectric loss factor tan δ	$3.5 \cdot 10^{-3}$ ...$1 \cdot 10^{-2}$ (in the range GHz-Hz)
Specific resistance ρ	~ 10^{16} Ω·cm
Dieelectric strengh	200-400 V/µm (on, e. g. Cu)
Soldering stability	270 °C/>1 min
Degradation (TG)	up to 400 °C
Water uptake	< 0.5%



4 Pentium™ MCM-L/D (ERICCON/ACREO)