Meeting the Extreme Challenges of Electronics

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Integrating electronics in plastic parts

Today's electronics demand more from plastics than ever before. Key trends – like miniaturization, "thinnovation", increased electrification in automobiles, and the need for more design freedom – are driving an increase in integration across the industry. One solution to these challenges shows a great deal of promise – the integration of electronic functionality into plastic parts. One of the main ways this is done is through the use of Laser Direct Structuring (LDS), which prints conductive traces on a 3D plastic part. An example of this is printing an antenna onto the frame of a mobile phone.

Using this technology, however, is not always straightforward. In the harsh environments of some automotive applications, effective use of LDS requires high-end material expertise to ensure part reliability. Some parts are exposed to extreme conditions, such as high continuous use temperatures, high humidity, and thermal shock caused by large temperature changes. Additionally, parts – such as those used in advanced driver assist systems, and sensing and actuation systems – are critical to the safety of the passengers, and need to perform flawlessly over the entire lifetime of the vehicle.

Performance during use is essential, yet we must also look at the challenges posed by production processes. Achieving electronic integration can expose materials to peak temperatures above 260°C in processes like reflow soldering. This means that when we develop different material grades, we must consider both the production of the part, and its performance in the application.

At DSM, we have a long history in both the electronics and automotive industries. Our ForTii® product line is a proven polyphthalamide (PPA) material that meets the demands of these ever-evolving industries. ForTii demonstrates excellent mechanical properties over a wide temperature range, with good chemical stability, and peak temperature resistance that has set the benchmark across the industry. The material is preferred for use in SMT connectors that go through reflow soldering, and it has a long proven track record in a variety of challenging under-the-hood applications.

ForTii in LDS part production

When producing parts using LDS, three characteristics are key to success: the plating index (how robust the plating process is, as a function of process conditions), design freedom, and adhesion (how well the conductive traces adhere to the plastic substrate).

Robust plating

ForTii delivers a consistently high plating index across the different LDS grades. This robust plating has been demonstrated with varying laser speeds, power, and pulse frequencies. Combined with fast copper initiation, it makes the entire process fast and reliable.

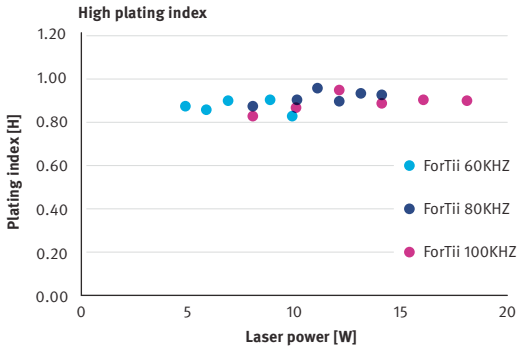

Figure 1 — Plating index of ForTii as a function of laser power and pulse frequency

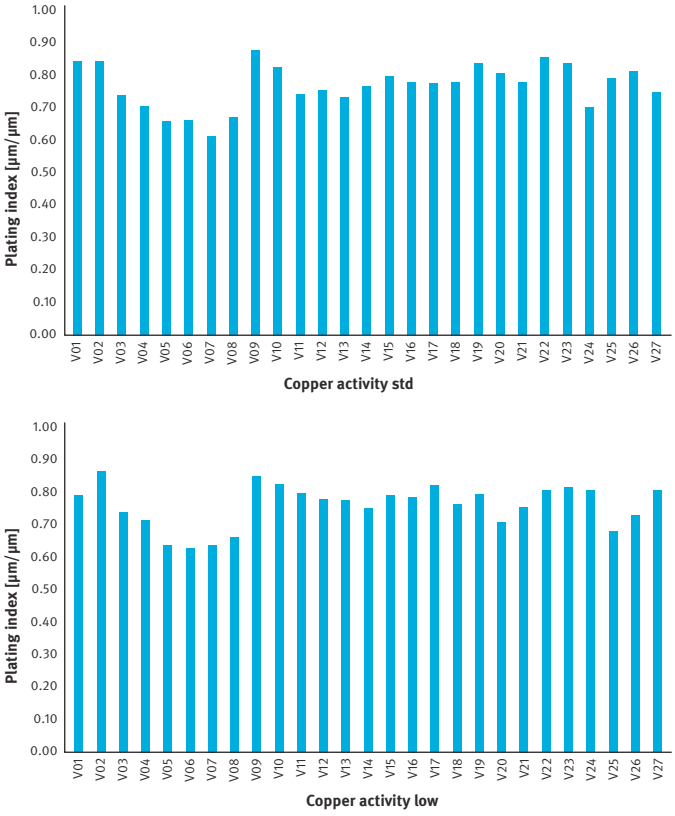

Figure 2 — Power: 2-8 W & speed: 2m/s & 4m/s

Design freedom and resolution

Part designers require more freedom and flexibility to manufacture parts in a wide variety of ways. ForTii demonstrates good weld line strength and appearance compared with competitive materials such as liquid crystal polymer (LCP). Strong and very flat weld lines enable designers to run tracks across weld lines, increasing design freedom for both the part and the tool used to create it (for example in gating positions). ForTii also enables very high resolution on commercial equipment (line widths of 80µm, combined with gap widths of 80µm), ensuring the quality of the circuitry design, and eliminating shorts and incomplete or open circuits.

Figure 3 — Very high resolution possible with ForTii

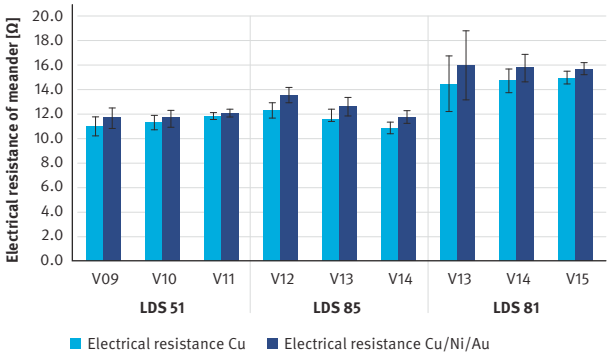

Figure 4 — No incomplete or open circuits for a wide variety of plating conditions with ForTii

Excellent adhesion

Parts manufactured from ForTii demonstrate superior adhesion, ensuring the integrity of the 3D circuitry. This has been verified under various test conditions defined by both the assembly process and the end-use environment.

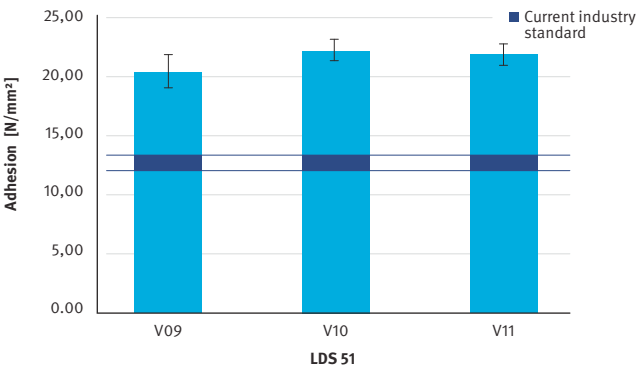

Figure 5 — Strong adhesion of the copper traces on ForTii, versus alternative materials

Performing in harsh environments

To ensure ForTii's performance in LDS applications subject to harsh environments, we have studied part performance under extreme conditions. After a simulated reflow treatment, which exposes the material to a temperature of 260°C for one minute, we subsequently exposed the material to:

- Temperature and humidity cycles according to USCAR T3
- Thermal shock, exposing the material to -40°C for one hour, followed by 125°C for one hour, over the course of 1000 cycles
- Testing in an environment with temperatures of 85°C and a relative humidity of 85% for up to 3000 hours

ForTii demonstrates very stable performance under all these conditions. In particular, the material samples showed no increase in circuitry resistance after 85/85 aging for 2000 and 3000 hours, while most competitive materials demonstrated a significant increase in resistance, indicating the presence of open circuits.

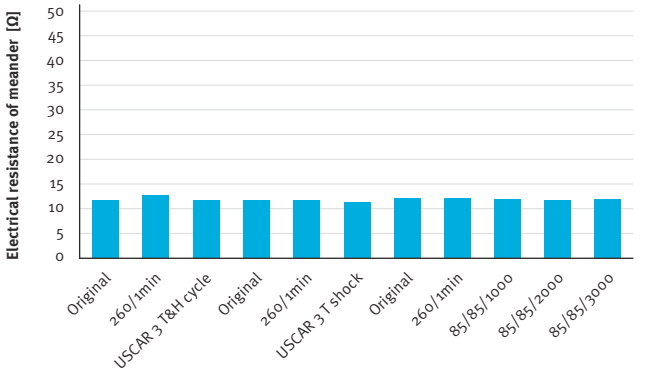

Figure 6 — Circuit resistance of plated ForTii for various aging conditions

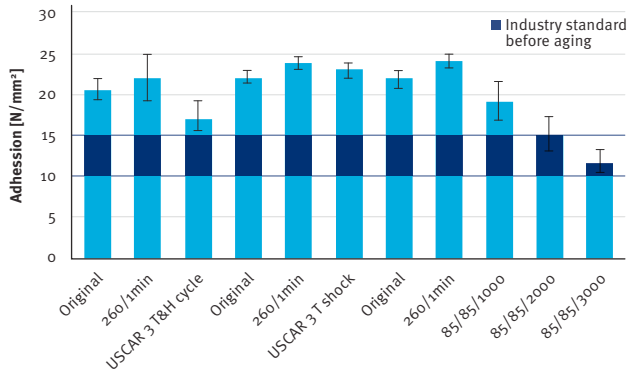

Figure 7 — Adhesion of copper traces to ForTii for various aging conditions

A ForTii grade for every LDS application

Our broad portfolio of materials includes three main products designed to meet the needs of different LDS requirements.

		ForTii LDS 62	ForTii LDS 51B	ForTii LDS 85B
Soldering process		Vapor phase and low temperature reflow	Reflow	Reflow
Flammability (UL94)	**UL94**	HB	V0	HB
Stiffness	**ISO 527 MPa**	9,500	11,000	10,000
Tensile strength	**ISO 527 MPa**	105	120	125
Elongation at break	**ISO 527 %**	2.3	1.6	2.0

Figure 8 — DSM portfolio of LDS capable materials

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