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Laser-induced selective metal plating on PP and PC/ABS surfaces for molded interconnect devices applications

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Laser-induced selective metal plating on PP and PC/ABS surfaces

Laser writing for selective plating of electro-conductive traces for electronics has several significant advantages, compared to conventional printed circuit board technology. Firstly, this method is faster and cheaper for prototyping. Secondly, material consumption is reduced, because it works selectively. However, the biggest merit of this approach is potentiality to produce molded interconnect device (MID), enabling creation of electronic circuits on 3D surfaces, thus saving space, materials and cost of production.

There are several techniques of laser writing for selective plating of polymers: metal nano-ink printing, laser-induced forward transfer (LIFT), laser-induced selective activation (LISA) and laser direct structuring (LDS). However, all of them, except LDS, have a limitation when it is being applied on a curved surface.

For our investigation, we used LDS and our new method: selective surface activation induced by laser (SSAIL). The main difference between LISA and SSAIL is that the second one is performed in atmospheric ambient. That simplifies the processing of 3D surface.

In the SSAIL method, pure plastics without any dopant (filler) can be used. SSAIL is a 3 step process. The first step is surface modification by laser, second – chemical activation of modified areas and the last step is electroless plating. In LDS method, special fillers are mixed in the polymer matrix. These fillers are activated during laser writing process and in the next processing step scanned area can be selectively plated with metals. There are some commercial materials available on the market for LDS; however, mostly they are based on expensive fillers, usually palladium. Considering the need of MID market, we are looking for the way to reduce the price of circuit traces manufacturing. Therefore, for LDS approach, we suggest new material: polypropylene with carbon-based additives, which increases the price of masterbatch much less than alternative additives used in polymers for LDS. While for the SSAIL method we used just commercial PC/ABS blend at all. Tests were performed using picosecond and nanosecond laser pulses. Different processing parameters (laser energy, scanning speed, the number of scans, pulse durations, wavelength and overlapping of scanned lines) were applied. A sheet resistance of selectively plated samples manufactured with different laser processing parameters and the same chemical bath conditions has been measured in order to determine the optimal regime of activation. Spatial selectivity tests showed high plating resolution. The narrowest width of plated line was less than 23 μm. The activation process was also investigated using Raman spectroscopy analysis. In Raman experiments, two spectra of treated and untreated plastic surfaces were compared. Finally, a prototype of the electronic circuit board was performed using both methods.