

Printing Technologies

Cost Effective Additive Material Deposition

Polymer based multifunctional 3D packages made by MID (Molded Interconnect Devices) technology combine high functionality and miniaturization at effective cost. While conventional MID technologies such as laser direct structuring or hot-embossing are used for the fabrication of conductive tracks, printing technologies allow for the deposition of a broad range of materials including conductors, semiconductors and dielectrics. At HSG-IMAT four printing techniques are available: Inkjet, Aerosol Jet®, Screen and Pad Printing.

Printing technologies offer a cost effective and flexible way to fabricate conductive tracks, isolation and passivation layers, passive and active devices as well as sensor structures. In addition to the broad range of substrate materials such as polymers, ceramics, silicon and metals there is a wide choice of functional materials which can be printed. Depending on the targeted application different printing techniques can be used. For example simple resistive structures can be easily printed by means of screen printing, while for the deposition of isolation layers pad printing is well suited. Two printing techniques which are investigated in detail at HSG-IMAT are the Inkjet and the Aerosol Jet® technology. Besides of being fully additive processes the desired patterns can be printed directly from CAD-data without the need of a mask. In conjunction with the ability to fabricate multi-layer-multi-material-systems and to print on simple 3D geometries this makes both technologies extremely flexible and cost effective. Additionally the inkjet printing technology distinguishes itself by high reproducibility and short processing times. Below some examples are given. Fig. 1 depicts several inkjet-printed silver tracks with a pitch of 150 µm and a track width of 90 µm on a PET+PBT substrate.

Characteristics

- Fully additive processes for many substrate materials
- Broad range of printable materials available
- Multilayer and 3D material deposition feasible
- Finest structure sizes down to 15 µm possible
- Flexible and cost effective technique

Applications

- Conductive tracks (also multilayer)
- Chip contacting
- Resistive sensors:
 - Temperature
 - Strain
- Passive devices:
 - Resistors
 - Capacitors
 - Coils
- Etch masks

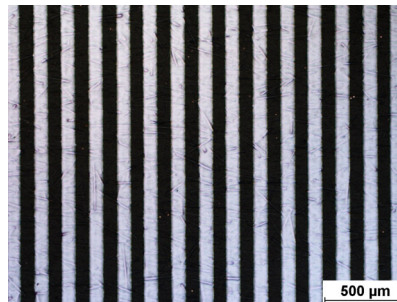


Fig 1: Inkjet-printed silver tracks



Fig. 2: Printed resistive temperature sensor

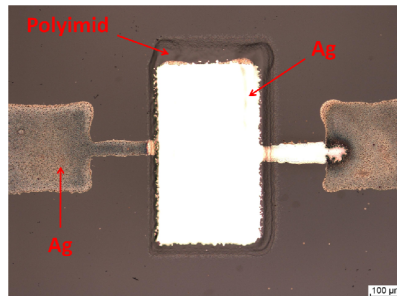


Fig 3: Aerosol Jet printed capacitor

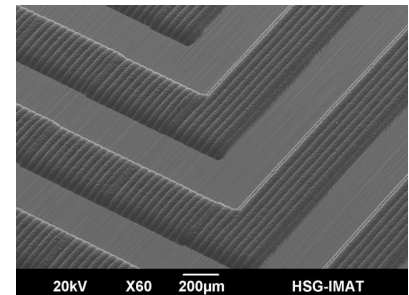


Fig. 4: Printed hotmelt-structure

Besides for strip lines printed conductive patterns can also be used for resistive sensors for i.e. strain or temperature. Fig. 2 depicts a silver based resistive temperature sensor with a temperature coefficient of 850 ppm/K and an accuracy of $\pm 2,0^\circ\text{C}$.

In Fig. 3 a polymer based capacitor fabricated by Aerosol Jet® printing is shown. While the lower and upper electrodes are both made from a commercially available silver ink, the polyimide dielectric has been depos-

ited from a formulation prepared at HSG-IMAT.

In Fig. 4 an Inkjet-printed hotmelt structure is depicted. Hotmelt is a special wax, which is solid at room temperature, but can be molten within the inkjet printmodule. After being deposited on the substrate material the hotmelt solidifies again and can be used as etch- or galvano resist structure for further processes.