Inkjet printing of nanomaterials for manufacturing electronic devices

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Inkjet printing process for graphic arts has been known for more than two decades but in recent years is observed as a novel manufacturing process. High accuracy, disposal of toxic waste and no need for additional tools attract electronic industry and turn revolutionary digital printing technology. Several companies are starting to manufacture PCB's, RFID's, OLED's and other electronic devices by inkjet printing and there is a large potential for TFT's, sensors, solar cells, etc…..

Main obstacle up to date is material formulation. It is not easy to find a jettable ink which is also a functional material for manufacturing electronic devices. To be jettable material must fulfil the following specifications:

- Viscosity must be low : 8-20 cps at printing temperature.
- Material surface tension and nozzle wettability must guarantee the correct drop formation.
- Material surface tension must be lower than substrate surface energy to ensure good adhesion properties. Most of substrates are also treated to optimise wettability.
- Particle size of material must be nanometric, otherwise printer nozzle would be clogged.

As expected, design of materials is not an easy task and future of inkjet technology as manufacturing process is linked to development of nanomaterials. It was only recently that these products are available. Silver nanoparticles dispersed in alcoholic vehicles have been already printed to form conductive tracks for PCB's. Great advantage of nanoparticles is their sintering temperature, lower than 200 ºC when diameters are below 50 nm. Conventional silver inks are dispersions of micrometric particles with sintering temperatures above 800 ºC and conductive paths for PCB´s are obtained by screen-printing. However, lots of ink are lost by etching away material and manufacturers are looking for "clean" processes. Inkjet printing avoids the waste of expensive material because is an additive and not sustractive technology and allows to obtain high values of conductivity, similar to those of screen-printed paths.

An industrial inkjet printer was built at CEMITEC with Spectra Nova printheads in order to deliver different functional materials for manufacturing processes. A nanoparticle silver ink was printed on a flexible poliimide, Kapton FPC from Dupont and conductive tracks were obtained once solvent was removed and particles were sintered. It was observed that conductivity values depend on curing temperature and curing time. Formulations of nanoparticle inks are being optimised in order to introduce inkjet technology at industrial scale.

The following pictures show some of the printed conductive devices: