Functional ink-jet printed materials

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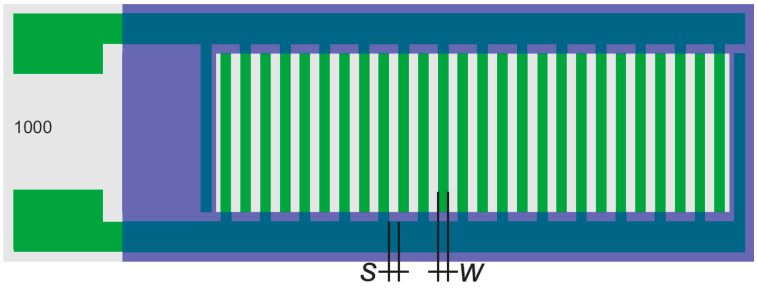
Recently, in electronic component fabrication, the dominant position of subtractive processes based on sequential etching through resist masks has been challenged by a new additive approach. The so-called material printing techniques are promising for the micro-fabrication of planar structures with a low level of integration. They are based on sequential laying of patterned functional layers by means of modified conventional printing techniques, which are considerably refined in sophisticated ink-jet printers where liquid volumes as small as 1 pL can be applied and a line resolution of a few μm can be reached.

Next to simple patterns mainly consisting of conductive traces for later integration of active electronic components, direct printing of semiconducting materials can be used to construct rectifying devices of interest in various applications.

This presentation concentrates on the formation and testing of electrochemical devices based on conducting patterns overprinted by semiconducting materials, in particular titanium dioxide. In order to fabricate a complete planar electrochemical cell, simple interdigitated finger patterns of conductors were printed. One finger family was subsequently overprinted by the semiconductor. For obtaining the desired thickness, the process could be repeated several times as highly reproducible repositioning of the print-head is possible.



Due to narrow finger width, *w*, and spacing, *s*, (down to 200 µm), operation in electrolytes of low ionic strength did not suffer from iR drop, as the underlying conductive patterns of such cells had conductivity cell constants down to 0.008 /cm.

Titanium dioxide was deposited using sol-gel processes, and coated electrodes, after annealing above 450°C, had properties similar to conventional anatase electrodes. The work was extended to cold-setting ink formulations in view of making devices on polymeric, flexible carriers.

Junctions of the electrodes with aqueous electrolytes showed rectifying behaviour and photocurrents resulting in IPCE values of up to 0.27 (at 355 nm) for 200 nm thick films.

Photoelectrochemical, oxidative degradation of organic compounds in solution was carried out under UVA illumination and electrical bias using terephthalic acid as a test compound. Degradation rate constants derived from initial rates of formation of hydroxyterephthalic acid, the first stable intermediate in the chain of reactions, were similar to those obtained with parallel plate flow-through reactors.