Sustainable production of large area electronics

for the solar industry and flexible electronic systems

Application

System integration on large area film substrates has paved the way to various new application scenarios for semiconductor and electronic products. Prominent examples are solar panels prepared on "endless" web substrates, extremely thin and bendable sensor film stripes for condition monitoring in large buildings or vehicles, health care monitoring systems to be applied on the surface of human skin and also very long, conformable and light weight wiring schemes in the fields of robotics and automation. All these applications require electrical circuits on large area substrates whereby consumption of materials and processing cost play a crucial role for the market success.

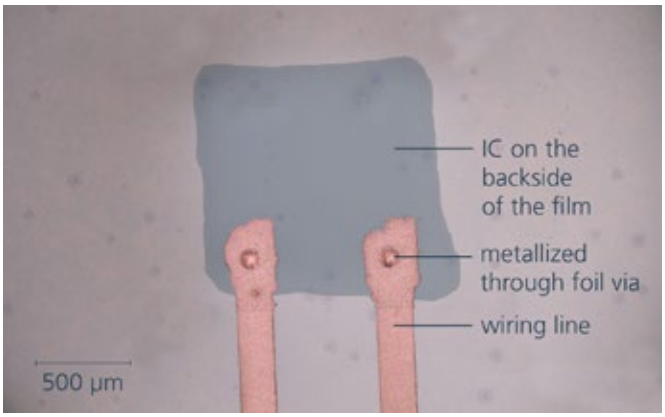
Demand for new technologies

State-of-the-art wiring systems on large area substrates are in most cases implemented using lithographically patterned copper layers or printed silver pastes. The first approach requires rather expensive photo-resist materials with an extensive waste of organic solvents. The main drawback of the second approach is the high price for the noble metal silver, which is roughly 50 times more expensive than copper. Furthermore, compared to standard copper lines, printed silver requires thicker layers to reach similar conductivity.

Today already 10 % of the global silver consumption is absorbed for production of solar

For flexible applications: Organic solar module manufactured in a roll-to-roll process

panels, where printed silver lines are required for the collection of photoelectrons. Anticipated growth of photovoltaic energy production in the world will likely result in a bottleneck in the availability of silver and a strong increase of its price.



Film substrate with direct integrated IC mounted face up on the film backside. The chip contacts as well as the wiring lines are realized by this new deposition technology. © Fraunhofer EMFT

New technical concept for sustainable large area wiring systems

The Fraunhofer institutes ISE and EMFT collaborate in the development of a new platform technology for manufacture of high-performance copper wiring schemes on polymer web substrates based on electroplating, waiving polymer photo-resists and organic solvents. The novel concept deploys laser ablation of very thin inorganic dielectric layers followed by e-plating on a thin copper layer underneath. This semi-additive plating technique minimizes the amount of all materials involved.

The new process concept also allows for direct integration of IC components on or in film substrates like for instance protective diodes that are required on large solar panels. Furthermore, the process scheme offers new solutions for simultaneous electroplating of IC interconnects and wiring systems (e.g. copper antennas) for hybrid integrated flexible electronics. An example for a direct integrated und interconnected RFID chip on a film substrate is shown in the picture. The electrical contact between chip pad and wiring line is established by a metallized through foil via.

State of development

The new cost-effective and resource-saving maskless electroplating process has been demonstrated in a roll-to-roll processing line at Fraunhofer EMFT. Wiring lines of a width and distance of 100 µm and below were prepared at high quality and yield.

Electrical interconnects between wiring and IC components were realized by ink jet printing of conductive silver inks through vias in the film substrate onto the contact pads of the semiconductor devices. The short and very thin silver ink lines are then reinforced by depositing several micrometers thick copper during the subsequent electroplating process. Thereby, the amount of applied silver is limited to the very short pathways in the vicinity of the via interconnect. Good conductivity is achieved by accurate copper deposition.

Advantages

This novel patterning and deposition technology allows for more economical and ecological production of large area electronics. The overall minimal material input, but especially the avoidance of organic solvents and photo-resist materials, leads to less waste and lower material cost. Doing without the noble metal silver contributes to responsible dealing with this material, which might become a critical ressource in the future.

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