Laser treatment of nano films

Task

Indium tin oxide (ITO) is used in the manufacture of transparent anodes for OLEDs (organic light emitting diodes) because it provides the best compromise between high conductivity and high transparency. Yet the rare metal indium is becoming increasingly expensive, making it all the more important to minimize wastage of the material during the coating process. The standard method of manufacturing structured anodes involves the use of conventional sputter techniques in conjunction with lithography or masking. A large proportion of the ITO used in these processes cannot be recovered (middle figure). The aim is to develop an additive process in which the requisite structure is applied without wasting material. The deposition of structured nanoparticle ITO coatings on glass or PET substrates, e.g. using an ink-jet printing process, represents a challenge in that the thermal post-treatment process - which is needed to reduce the surface resistance of the dried layers - requires temperatures that exceed the temperature stability point of the substrate. Laser treatment overcomes this drawback by virtue of its rapid heating and cooling rates that allow the required temperatures to be reached in the coating layer without affecting the substrate material.

The laser post-treatment of nanoparticle-based ITO films represents the key to the efficient use of materials when manufacturing structured films with defined functions such as low sheet resistance and high transparency.

Method

The first stage of the process involves creating a dispersion of ITO nanoparticles (figure below). Additives are employed to modify the properties of the dispersion so that it can subsequently be deposited on the substrate to form the required defect-free structure using an ink-jet printing process. In the final stage, the deposited film undergoes thermal post-treatment through exposure to laser radiation, which results in the specified sheet resistance through a combination of thermal compression and sintering.

Results and Applications

Thermal laser post-treatment reduces the sheet resistance of 800 nm thick films on glass by several MΩ/sq to less than 150 Ω/sq with a speed rate of 14 cm^2/s. The layer transparency remains more than 98 % (at 550 nm). Such films can be employed in the manufacture of electroluminescent light sources (figure above) or displays with low information content, such as pricing displays.

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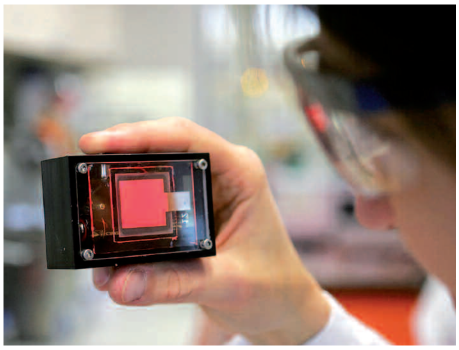

Above: Demonstrator of an electroluminescent light source.
Middle: Comparison of a conventional sputter process with the ink-jet printing and laser process.
Below: Basic process principles.