Lift-Off For A New Paradigm: From Glass to Polymer

Laser processing is a key technology in driving new paradigm in microelectronics which is transferring a microelectronic functional layer onto a thin and lightweight polymer substrate.

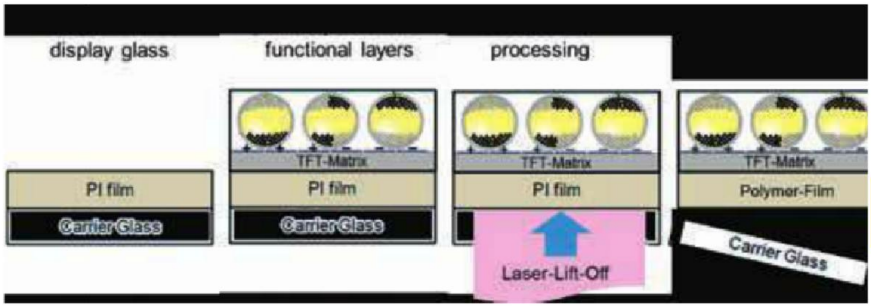

Photo: Coherent

Fabrication scheme of flexible displays by means of laser-lift-off.

Laser-lift-off separation of the initial glass carrier is achieved by means of selective laser ablation and evaporation of the strongly absorbing polymer interfacial area. It is of imperative, that the adjacent microelectronic functional layer is not deteriorated by the laser energy. Therefore, the laser-lift-off method for selective thin layer separation has become the realm of short-wavelength lasers and of the excimer laser at a wavelength 308 nm, in particular.

In order to achieve fast and reproducible laser-lift-off separation on an industrial scale, laser-lift-off processing occurs via scanning the substrate using a some 100 μm wide line beam of appropriate length (line-scan-method). Recently, large line lengths of up to 1,300 mm have made it to the OLED production floor enabling the rapid separation of functional display layers even in the case of generation-8-size substrates (2,500 x 2,200 mm²).

Flexible displays, whether they will be employed in OLED TVs, smartphones, tablets or e-readers, always share a common feature: the backplane of circuit layers used to individually drive each pixel are no longer situated anymore on a rigid glass carrier but instead on a flexible polymer foil. Polymer-based backplanes can drive an LCD, an OLED or an electrophoretic display. In the latter display type, the transition from the ca. 1 mm thick glass carrier to the just about 100 μm thin polymer foil leads to a 50 percent reduction in weight and a 30 percent reduction in design height. Another general advantage is the ruggedness of the polymer based display against mechanical impact.

The essential process steps used for the fabrication of polymer-based displays are schematically illustrated in Figure 1, in this example forming part of an electrophoretic display as it is commonly applied in e-readers. As the first step a temporary glass carrier substrate is spin-coated with a 100 μm thin polymer film which is cured thereafter. On top of the polymer layer will be built the circuit backplane, i.e. the matrix of thin film transistors (TFTs) followed by the display frontplane which contains the layers for electrodes and microcapsules. Finally the transition from rigid to flexible display is realized by laser-lift-off processing. Technically, the excimer laser line-beam of a wavelength of 308 nm is shown through the carrier glass substrate on the polymer. Only the polymer in direct vicinity of the glass substrate, i.e. to a depth of ca. 0.1 μm, is evaporated; each area by a single pulse of ca. 25 ns using an energy density of ca. 200 J/cm².

A huge advantage of starting from temporary glass substrates in combination with laser-lift-off processing lies in the fact that the display manufacturer can extend his portfolio from rigid glass based to flexible polymer based display backplanes, without the need for major investments in completely new production equipment.

Laser-lift-off enables material-friendly substrate separation in the industrial production of lightweight and ultrathin organic electronics. Excimer lasers deliver the necessary ultraviolet pulses thus opening the path to polymer based microelectronics future. \\

Dr. Ralph Delmdahl
Product Marketing Manager
COHERENT
www.coherent.com

Photo: Coherent

Laser lift-off display glass panel separation from polymer film employing a 750 mm long line beam.