Aims of ALABO project

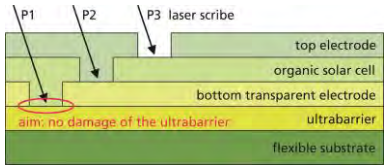
The overall objective of this project is to develop organic electronic building elements on flexible substrates with monolithically integrated barrier foils as substrate. The barrier acts as the inevitable protection against atmospheric gases as water vapor and oxygen, as the most crucial agents for unwanted material degradation processes.

To enhance lifetime and cost-performance-ratio of advanced Thin Organic and Large Area Electronics (TOLAE) components direct laser scribing processes on flexible substrates, coated with ultra-barrier systems, as well as new production technologies supported by dedicated monitoring and material testing technologies for well scalable manufacturing processes were developed.

Organic photovoltaic (OPV) modules have been chosen as test objects for a scalable and general approach suitable also for other TOLAE devices such as OLED, OTFT and thin-film inorganic PV on polymer foil substrates.

As an outcome of the project, more functionality will be integrated into less material, since - in contrast to state-of-the-art encapsulation processes - the TOLAE devices will need only one foil per side, instead of at least two today.

One important key for the success of the ALABO project is the close collaboration of the consortium. The consortium includes 3 multi-national industries cooperating with 3 Institutes for industrial research and an University from 4 European countries.



Project aim: Laser scribing while maintaining ultra-barrier properties

Project partners

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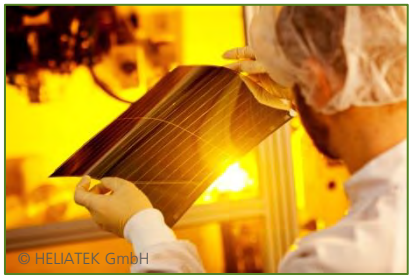
Advanced Laser Ablation on Barrier films for Organic and large area electronic devices



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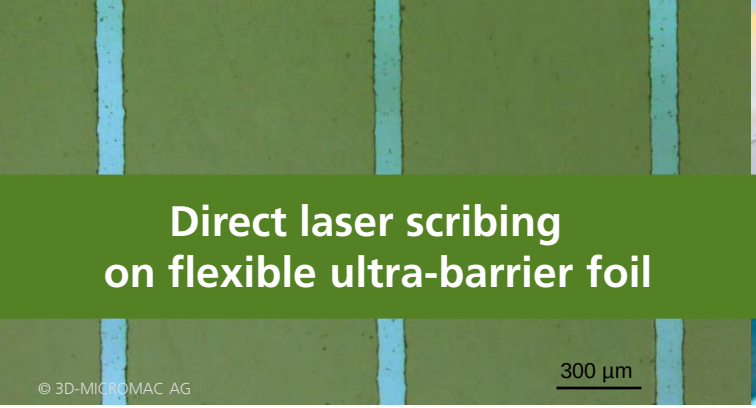
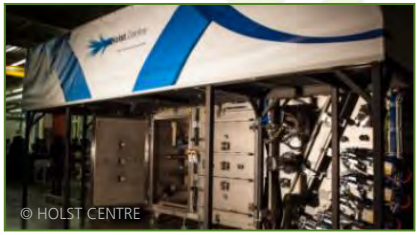


Direct laser scribing on flexible ultra-barrier foil

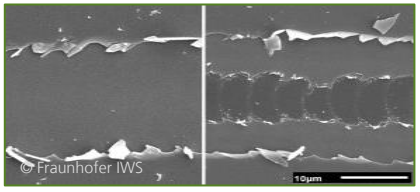
The new concept to use barrier foils as substrate in the organic photovoltaic roll-to-roll (R2R) process needs the development of innovative laser process for all structuring steps.

The developments address innovative processes for structuring the bottom electrode (P1), the organic layer system (P2) and the top electrode (P3) without damaging the ultra-barrier layer to guarantee the barrier performance of WVTR ≤ 10^{-5} g m^{-2} d^{-1}. In parallel the barrier will be further optimized regarding the requirements of their adaptation to the laser process.

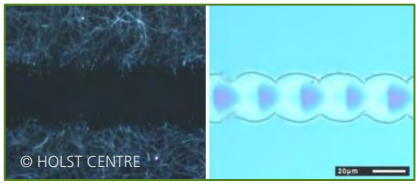
Ultra-short pulse lasers in ps- and fs-regime with standard wavelength as well as lasers with a dedicated wavelength (2 µm regime) are studied with respect to the specific industrial requirements.



R2R equipment for manufacturing ultra-barrier webs (WVTR: 10^{-6} g m^{-2} d^{-1}) for organic electronics (Holst Centre)



SEM of femtosecond-laser machined DMD-coated P2 substrate below (left) and above (right) threshold



Nanosecond-laser machined AgNW-coated (left) and picosecond-laser machined ITO-coated (right) P1 substrates

Scale up of laser scribe processes to roll-to-roll production

The transfer of laser scribing technologies into large-area, large volume OPV production using R2R processes is high challenging. Driven by the strong need of a cost-efficient OPV production the web width increase from 300 mm to at least 1200 mm has to be considered as well as a target web speed of 5 m/s. Technologies to speed-up the laser scribing process by new speed beam deflection systems are developed to meet the R2R processing demands.

R2R printing and laser structuring machine (3D-Micromac AG)

R2R production of HeliaFilm® (Heliatek GmbH)

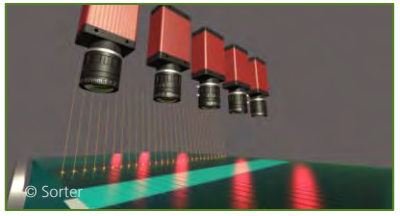
Advanced analytical and monitoring tools

To support the development of the laser processes the performance of the ultra-barrier are evaluated by their Water Vapour Transmission Rate (WVTR), which describes how much water vapour penetrates a certain area of a barrier material in a certain time. The usage of different measurement technologies (He-test, Ca-test, TDLAS) enables in an excellent manner the evaluation of barrier performance after laser treatment on the one hand and the comparison of the performance of these for ultra-barrier measurement technologies on the other. Based on the rapid Helium barrier test an innovative concept for online analysis of barrier webs in R2R machines will be studied.

Furthermore to monitor the ablation process especially to detect the endpoint of laser treatment continuously a Laser Induced Breakdown Spectroscopic (LIBS) system is developed and tested.

As a further significant tool to improve the reliability of the laser scribing process a fast vision system combined with a real time image processing are developed to control the scribe alignment and necessary readjustment during the R2R manufacturing.

Measurement of barrier webs for organic flexible electronics with WVTR up to 10^{-6} g m^{-2} d^{-1}



3D visualization of camera positioning in the R2R process