



# Endless Electronics

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## by Roll-to-Roll processing

### Demand

There is a variety of use cases that require extraordinary form factors for electronic circuits and systems: sensor stripes of several meters in length will be required to monitor the safety and functionality of machines, buildings and vehicles or to acquire data from the surface of wings and rotor blades. There is also high interest arising from new monitoring systems in healthcare: this will comprise sensors on the human body or in the mattresses of hospital beds as well as “smart floors” in homes for the elderly. For such use cases, electronic sensor systems should be preferably prepared on meter-long sensor stripes, including the integration of active and passive components. Today, conventional PCB

(printed circuit board) technology is limited to product size below 60 cm in length. This is by far not sufficient for the application scenarios described above.

### Innovation

New technical solutions are now being offered by roll-to-roll manufacturing concepts. Polymeric films are used as base substrates for wiring systems and device integration. Polymer film materials like PET, PEN or polyimide may be procured as rolls with lengths of five hundred meters and thereby offer a unique solution for the production of several meter-long electronic systems. But how can high resolution lithographically defined metal patterns be prepared without interrupting long conductive

Roll-to-roll  
manufacture  
enables new  
form factors  
for flexible  
hybrid  
electronics!

lines? The key innovative solution here is based on direct write lithography systems: instead of using photomasks and full area UV exposure of the photoresist, a micrometer fine UV light beam (coming from laser or LED optics) is precisely scanned over the resist and “writes” the desired pattern into the resist layer. The composition of the whole pattern requires a certain overlay area at the edge of the subsequently exposed designs, which is possible with an accuracy of just a few microns. Further advantages of this novel digital process are the instant availability of the designs (and also re-designs) after the layout work and the freedom to combine several customer designs in the same technology run.



### Demonstrators for “endless electronics” at Fraunhofer EMFT:

The picture on the front page shows an example of a 2-meter long sensor stripe with integrated MEMS based pressure sensor elements. The sensing devices are connected by a digital data bus. Interesting applications for such thin and flexible long stripes are measurements of air flows and pressure at the surface of an aircraft wing or data collection from the rotor blades of wind turbines. By adding further sensor components, these stripes allow for monitoring of a set of condition parameters like deformation, vibration and mechanical impact. One of the unique advantages of film-based electronics is the extremely thin form factor. In particular, sensing devices for air flow measurements on a wing must not disturb the air flow by changing the surface topography. Advanced embedding technologies enable keeping the thickness of the stripes below 0.5 mm.

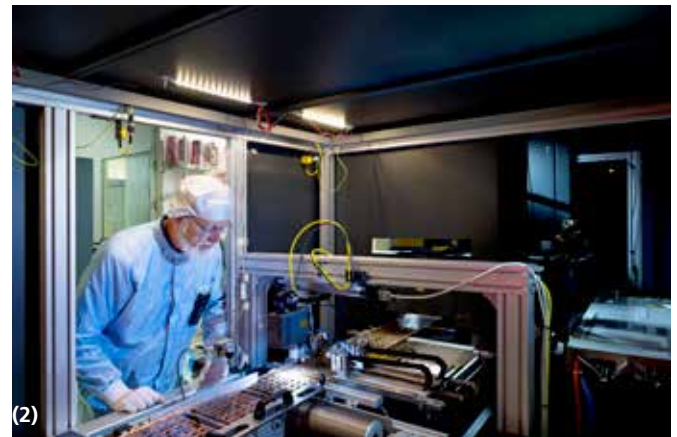
### Flexible Hybrid Electronics (FHE)

Fraunhofer EMFT has set up a roll-to-roll pilot line for “Systems-in-Flex”. Innovative new equipment has been installed at the institute within the framework of the “Research Fab Microelectronics Germany”, funded by the German government. The processing capabilities comprise thin film metallization (“sputtering”), lithographic patterning, screen printing, wet-chemical

processing, laser structuring, die and component assembly and film stacking. All new tools allow for both roll-to-roll manufacturing and sheet-based processing. This roll-to-roll pilot line is supposed to establish an open technology platform for Flexible Hybrid Electronics in Germany. Both customers and project partners can benefit from this new platform and Fraunhofer EMFT’s know-how through development of new applications in the field of “endless electronics” as well as through utilization of low-cost roll-to-roll manufacturing methodology with flexible thin films.

### Funding

This work has been supported by BMBF, German Federal Ministry of Education and Research, within the frame of “Forschungsfabrik Mikroelektronik Deutschland” and the BMBF research project ADAMOS, contract no 16ES0727.



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*Picture front side: 2 m long sensor stripe with integrated MEMS pressure sensors*

*Pictures this side: (1)Thin Chip Foil Packages (before singulation); (2)Look inside a roll-to-roll laser processing equipment*