Hybrid Integrated High Performance Electronic Stripes

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1 Aim of the project

HyPerStripes develops, evaluates, and provides technologies for long smart and flexible electronic systems to replace traditional cables and to enable new products in applications that require both a high performance and a high level of integration such as medical devices, medical instruments, and eco-friendly LED surfaces.

2 Contribution from Fraunhofer EMFT

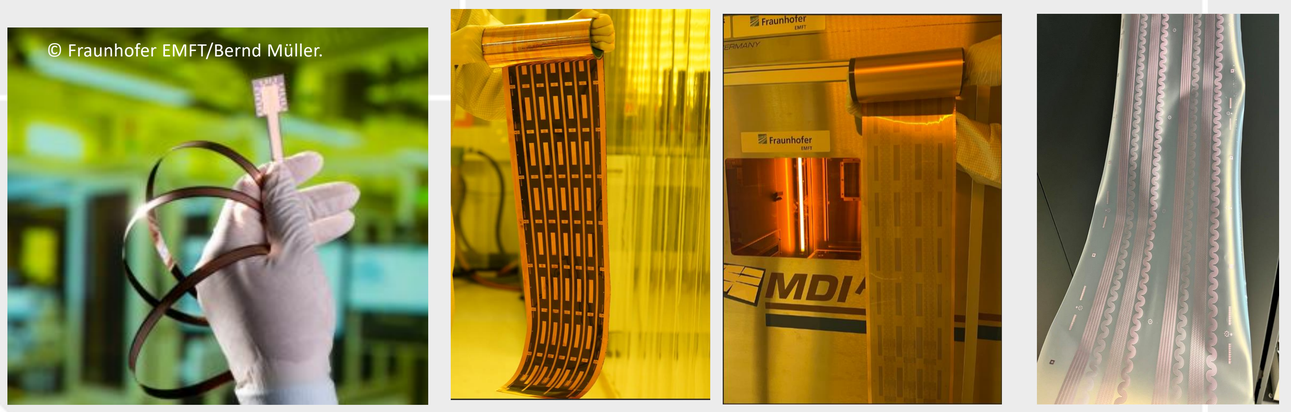
In order to produce cables of 1 meters or longer, we utilize our pilot line of roll-to-roll technology developed at Fraunhofer EMFT. The approach, combined with specialized R2R processes and machinery, enables the precise creation of metal patterns on flexible and stretchable substrates. A key component of this fabrication is the integration of a unique digital lithography stitching technique, which allows for the production of high-quality, durable cables at extended lengths.

3 Schematic of Digital Lithography Process on Flexible and Stretchable Substrates

The fabrication of the long cable consists of metal deposition on a flexible substrate, followed by lithography and etching(for Cu thickness up to 500 nm), or electroplating (for Cu thickness of 5-10µm). The semi-additive electroplating process enhances sustainability in metal patterning on flexible substrates by significantly reducing metal waste. In this process, metal thickness is selectively increased through electroplating, requiring only a thin seed layer, typically in the nanometer range, to be etched away. This contrasts with traditional methods, where thick metal layers—often several microns—are etched, generating substantial metal waste. By minimizing etching, the semi-additive process reduces both material consumption and chemical waste, making it a more environmentally friendly and resource-efficient alternative.

4 Stitching technique for long Cu Stripes by Digital Lithography

The optical contrast of the UV-exposed photoresist is used to align consecutive line segments. Of the two concepts developed for this technique, in the HyPerStripes project, a new set of alignment marks are positioned during the exposure of each line segment, which can be used to align the next exposure. The process start with the cutting of the desired design into multiple sections and modified to include alignment marks for the stitching process. The digital lithography tool calculates the misalignment (offset, rotation) and the difference in the image size (heat shrinkage and/ or stress in the foil). The tool can adapt the size and the rotation of the image to make it fit on the alignment marks and can compensate upto 0.6° rotational and 0.4% shrinkage errors.



5 Design rules for R2R Digital Stitching

Min. width/pitch size (µm)	50/50 µm line/ space At a small scale 20/20 µm
Metal thickness	500nm-9µm thickness possible at 100 /100 µm line/space
Register (repeating pattern)	200x200 mm Stitching possible to accommodate endless wires
min./max. foil/substrate thickness (µm)	Polyimide 25-125 µm TPU 100 µm
Width (mm)	Max. foil width is 215 mm

6 Acknowledgement

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