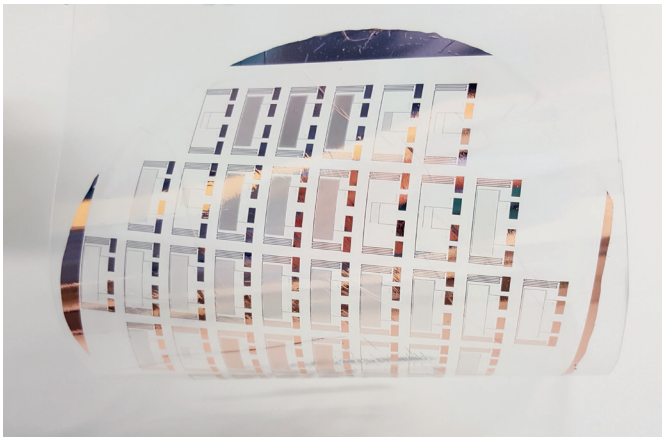
Fraunhofer ENAS

Technologies

Ultra-thin and highly flexible Parylene-based PCB with multiple metallization layers

Fast Facts

- Parylene as a substrate, dielectric and encapsulation
- Total thickness < 20 µm
- Multiple metallic redistribution layers
- Different metals and metallization techniques
- Vias with low depth < 10 µm
- Good electrical performance
- High bendability
- Optical transparency
- Biocompatibility and biostability



Flexible Parylene substrate metallized by sputtered and wet-chemically etched copper.

General Description

Following the current trends towards Industry 4.0 and the Internet of Things, flexible electronics and sensors are a key enabling technology for the realization of wearables and geometry adaptive devices. Fraunhofer ENAS presents a new approach for the fabrication of an ultra-thin and highly flexible printed circuit board (PCB), featuring multiple metallization layers.

For the realization of this advanced ultra-thin and highly flexible PCB, Parylene was used as a substrate material, for the dielectric layers between the metallic redistribution layers (RDL) as well as for the encapsulation. Parylene (Poly[p-xylylene]) is a group of thermoplastic polymers, which combines excellent properties such as biostability and biocompatibility according to ISO 10993, optical transparency, low permeability for moisture and gases, a comparably high temperature stability, and a low coefficient of friction. Particularly, the dielectric properties, the low Young's modulus and the mechanical stability of thin film Parylene at thicknesses between 10 – 20 µm enable Parylene to be a good choice for the usage as a substrate and dielectric for flexible PCBs. Its chemical inertness against all common acids, bases and solvents ensures the compatibility of Parylene with established microtechnologies.

Using microtechnologies such as sputtering and electrochemical deposition or additive manufacturing technologies such as printing, Parylene can be metallized with a variety of different metals and structure dimensions of down to 10 µm. The fabricated ultra-thin flexible PCB offers three or more metallic RDLs and a total thickness of less than 20 µm. Doing so, the different RDLs

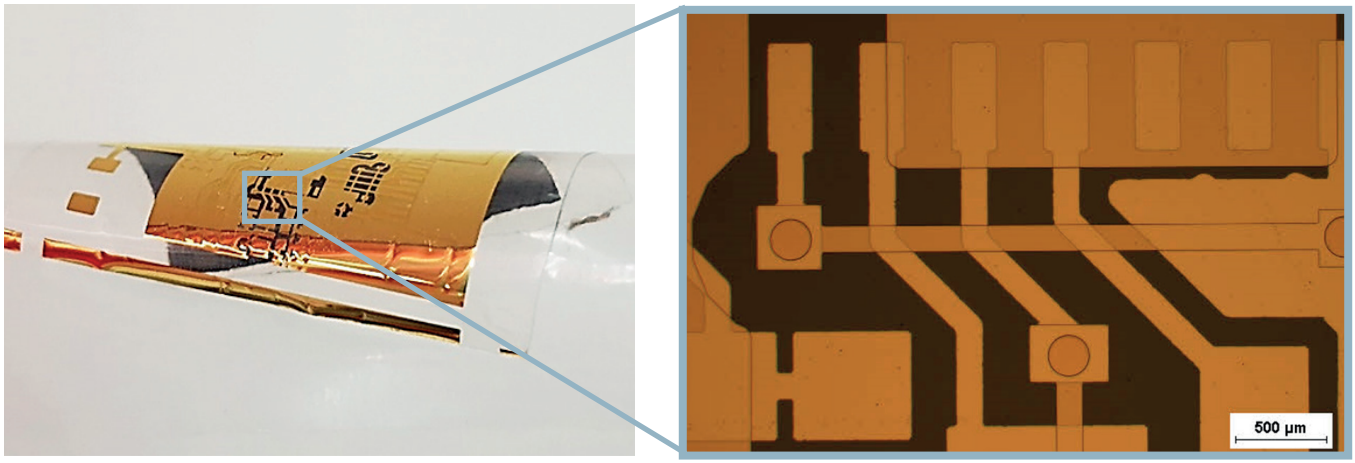


Photo and light microscopic image of the fabricated ultra-thin flexible Parylene PCB with two RDLs.

are electrically connected by through Parylene Vias with a low aspect ratio. The dimensions enable a high bendability as well as an optimal integration. Applications include the embedding into lightweight structures for structural health monitoring or, the usage as smart adhesive tapes for geometry adaptive sensing. Utilizing the biocompatibility of Parylene, fully biocompatible flexible PCB and packaging platform can be realized, addressing applications in the field of medical wearables and implants.

Options for metallization

- Sputtering and wet-chemical pattern or lift-off: Au, Al, Cu, Ti, Cr, Pt, Pd
- Aerosol-jet printing: Ag, Cu, Au
- Screen printing: Ag, Ag/AgCl
- Electrochemical deposition: Al, Cu, Au

Options for Integration and Packaging

- Soldering
- Wire bonding
- Embedding with selective media access
- Embedding with encapsulation
- Dispensing
- Printing

Selected Applications

- Flexible electronics
- Integrated electronics in lightweight structures
- Smart adhesive tapes
- Medical implants such as neuronal probes and retina implants
- Medical wearables such as sensors for monitoring vital signals or smart plasters

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