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PRESS RELEASE

Fraunhofer ENAS successfully manufactures ultra-thin and highly flexible Parylene-based Printed Circuit Boards with several metallization layers

Scientists at the Fraunhofer Institute for Electronic Nano Systems ENAS in Chemnitz successfully developed and manufactured flexible printed circuit boards with an overall thickness of less than 20 micrometers and several metallization layers based on the polymer Parylene. The institute presents the new generation of flexible PCB this fall at the COMPAMED and the SEMICON Europa 2021.

For the realization of advanced smart applications such as smart medical wearables, smart adhesive tapes or structural health monitoring of lightweight structures by integrated sensors, flexible electronics and in particular flexible printed circuit boards (PCB) are a key enabler. For the given applications, the thinner flexible printed circuit board are preferred in comparison to thicker designs, since lower total thicknesses come along with better wearing comfort, e. g. considering medical wearables for monitoring vital parameters or smart plasters. Similarly, thinner flexible sensors for structural monitoring can be better integrated in lightweight structures than thicker ones. For existing technologies for flexible PCBs, the total thicknesses can easily cumulate up to several 100 µm, particularly if they include several metallization layers. This limits their flexibility and integratability. Scientists at Fraunhofer ENAS have now succeeded in producing an ultra-thin and flexible printed circuit board with several metallization layers.

The decisive factor here was the use of the polymer Parylene, which is deposited at room temperature, and hence, without any intrinsic stresses. It provides a good mechanical stability, even for low layer thicknesses, while featuring a low Young's modulus and hence, a high bendability, even at low temperatures. At the same time, it provides a comparably good thermal stability. Under these conditions, it was possible to extremely reduce the overall thickness of the Parylene-based PCB while at the same time realizing a high degree of flexibility.

IN COOPERATION WITH

ZfM Zentrum für Mikrotechnologien

TECHNISCHE UNIVERSITÄT CHEMNITZ

Editors
Dr. Martina Vogel | Fraunhofer Institute for Electronic Nano Systems ENAS | Phone +49 371 45001-203 |
Technologie-Campus 3 | 09126 Chemnitz | Germany | www.enas.fraunhofer.de | martina.vogel@enas.fraunhofer.de

Expert
Franz Selbmann | Fraunhofer Institute for Electronic Nano Systems ENAS | Phone +49 371 45001-491 |
Technologie-Campus 3 | 09126 Chemnitz | Germany | www.enas.fraunhofer.de | franz.selbmann@enas.fraunhofer.de

In addition, the polymer offers other advantageous properties that are crucial for subsequent use in very different applications. These include ISO 10993 certified biocompatibility and biostability, chemical inertness and thus compatibility with common microtechnologies, optical transparency, electrical isolation and a low permeability.

Using Parylene to realize advanced flexible PCBs, the polymer unites three different functionalities: It acts as a flexible substrate, as a dielectric between the different metallic redistribution layers as well as an encapsulation layer. The Parylene-based flexible PCBs are fabricated using established microtechnologies, allowing a variety of metallization technologies such as sputtering or additive manufacturing based technologies and different metals to be used for the fabrication of the metallic interconnect layers. Doing so, smallest dimensions as low as 10 µm can be realized. For the realization of vertical interconnects between the metallic layers, the intermediate Parylene dielectric with a thickness of only a few micrometers is patterned, whereas different methods can be applied to fill the resulting via again. Using these technologies, total thicknesses of less than 20 µm can be achieved for Parylene-based flexible PCBs – even if they contain several metallization layers.

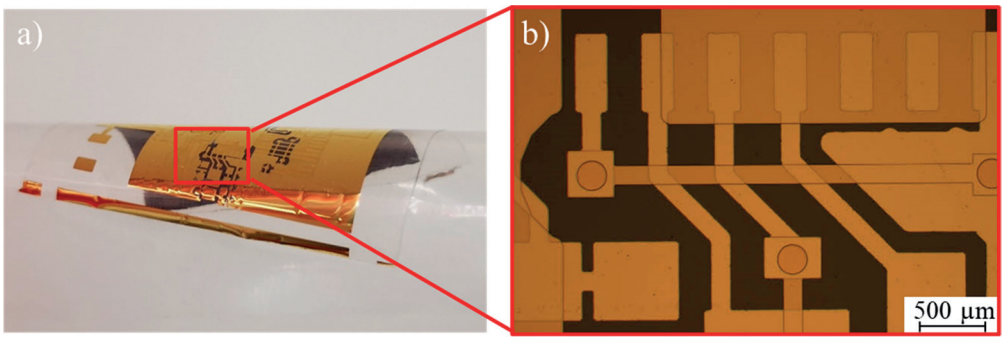

Photo (a) and microscopic image (b) of an ultra-thin flexible Parylene-based printed circuit board with two metallization layers of gold.
Photo © Fraunhofer ENAS

Based on its unique features, this new generation of ultra-thin and highly flexible PCB based on Parylene can thus provide an advanced packaging platform for enabling new smart applications in the field of flexible electronics. Due to biocompatibility of Parylene, particularly the fabrication of a fully biocompatible PCB is possible, when choosing biocompatible metals such as gold or titanium.

The development was already presented in the paper "An ultra-thin and highly flexible multilayer Printed Circuit Board based on Parylene" at the Smart Systems Integration Conference, which took place online in April 2021. Now Fraunhofer ENAS will show the Parylene-based circuit boards live for the first time at COMPAMED in Düsseldorf from November 15 - 18, 2021, and SEMICON Europa in Munich from November 16 - 19, 2021.