Karlsruhe Institute of Technology

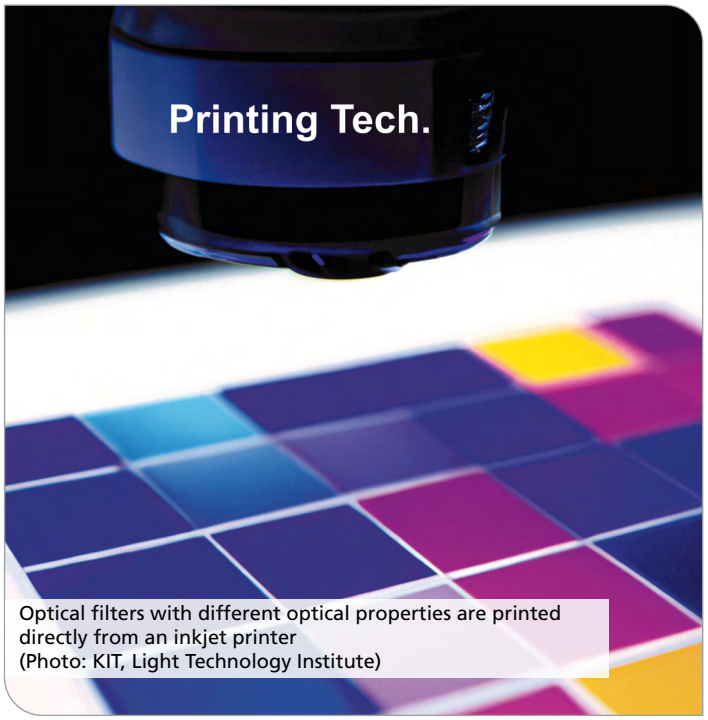
Division III – Mechanical and Electrical Engineering

Light Technology Institute (LTI)

IJPOFs – Inkjet Printed Optical Filters

Additive Manufacturing of Highly Customized Optical Filters

Optical filters can selectively reflect or transmit the spectrum of the light of interest. Such filters exist in many optical systems. They block or amplify a certain part of the spectrum to realize special functions. Recent advances in machine vision, AR and VR technologies, autonomous driving, medical inspection, and laser materials processing require an enormous number of optical filters. The spectral functions and sizes of the filters vary constantly. Inkjet Printed Optical Filters (IJPOF) offer an industry-relevant solution to reducing manufacturing costs and increasing customization flexibility.



Optical filters with different optical properties are printed directly from an inkjet printer
(Photo: KIT, Light Technology Institute)

Main features of IJPOFs

Unlike pigment/dye-based optical filters, IJPOFs are based on multi-layer interference mechanisms. The latter enable the development of optical filters with near-zero light absorption and precise control of optical properties. The spectral reflectance or transmission peak wavelength and the bandwidth of the spectrum in the visible and near-IR regions is determined by the thickness of the individual layers and the structure of the stack. Optimal nanometer precision is achieved by controlling the ink concentration and the number of ink droplets deposited per unit area.

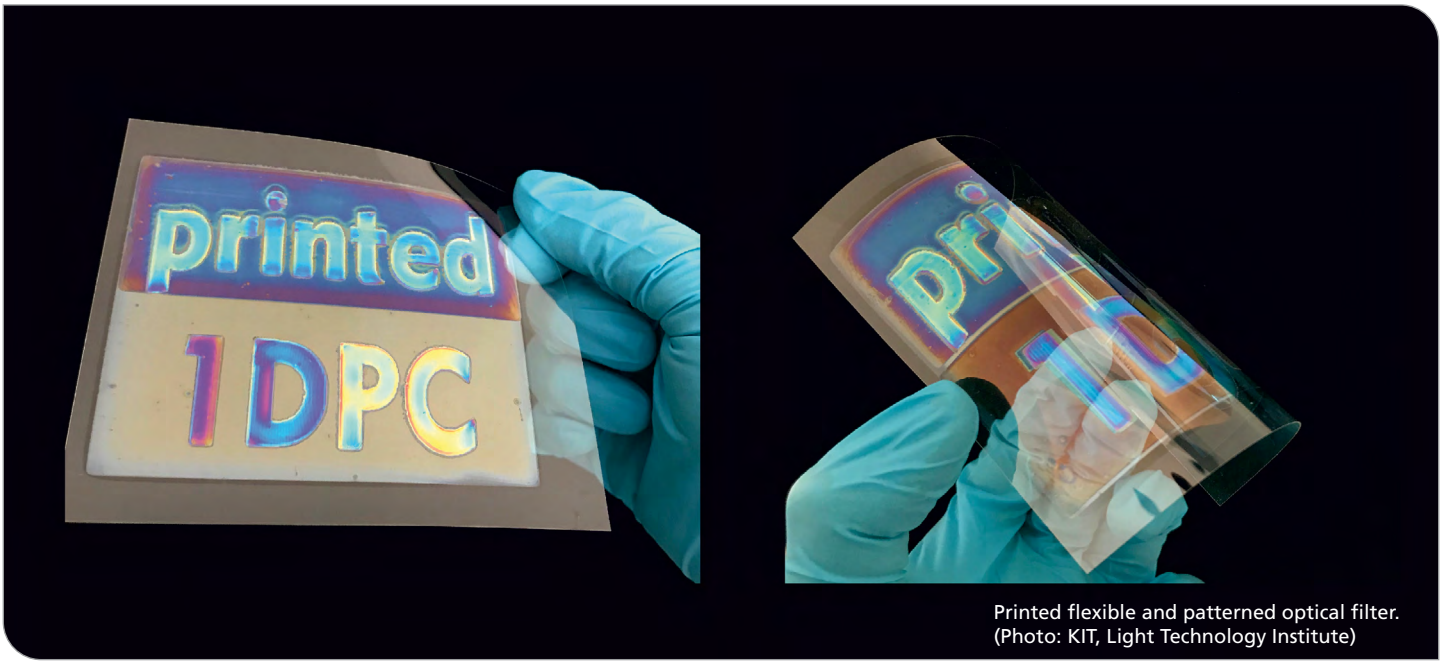
Inkjet-printed optical filters with different optical properties
(Photo: KIT, Light Technology Institute)

Advantages of IJPOFs

Optical filters are usually manufactured under ultra-high vacuum conditions. The size of the filters in batch production is limited by the size of the vacuum chamber. With the inkjet printer, the size limitation can be overcome and a larger, continuous production of optical filters under normal ambient conditions can be realized. This drastically reduces production costs. On the other hand, inkjet printing is a drop-on-demand technology. This means that masks are not needed if a certain structuring of the filters is required. It also makes it easier to produce optical filters in the desired locations and sizes.

Industry Application Scenarios

Inkjet printing is an extremely flexible technology. On the one hand, a single filter size can be produced from a hundred micrometers to one meter, and on the other hand, it is relatively easy to image filters with different optical properties, from the ultraviolet to the visible through to the infrared spectrum, as an array. The developed technology can help reduce manufacturing complexity in systems such as cameras, displays, smartphones, car sensors, etc. The spinoff company Prio Optics is in preparation.



Printed flexible and patterned optical filter.
(Photo: KIT, Light Technology Institute)

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