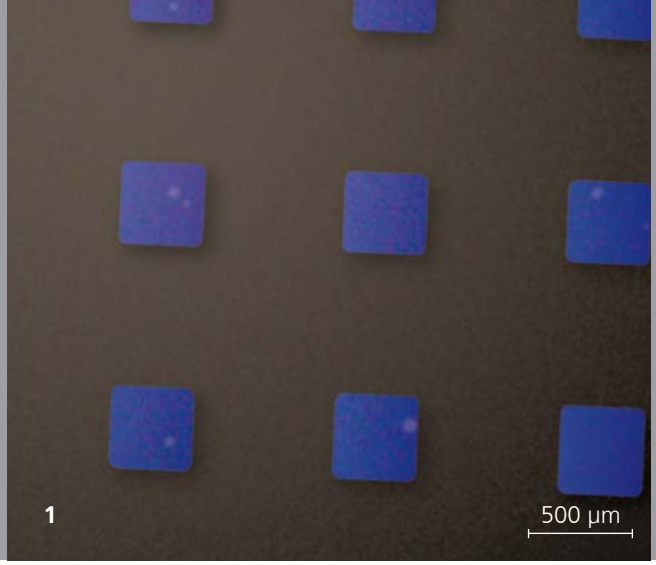

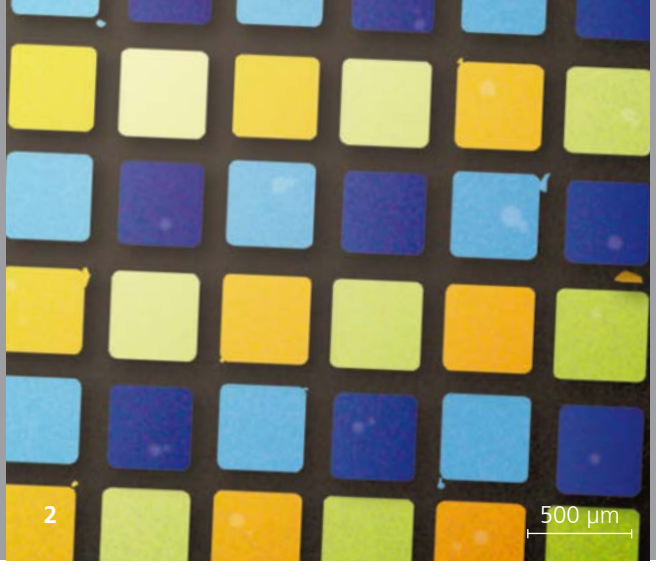

PIXEL FILTERS – MICROSTRUCTURED THIN FILM FILTERS FOR 3D METROLOGY

Microstructured filters are playing an increasingly important role, especially in the field of high-resolution 3D metrology or even in hyperspectral imaging. A new combined process for the production of these so-called pixel filters has therefore been developed at the Fraunhofer IST, consisting of coating and microstructuring. Here several dielectric filters are arranged side by side on a substrate, so that, for example, with the aid of a CCD sensor different wavelengths can be filtered out depending on the pixel element. So far it has been possible to achieve structure sizes of less than 100 µm which can be used both as bandpass filters and as cut-off filters.

Production of the microstructured thin-film filter

The structured filter is created in several alternating coating and structuring steps. The so-called lift-off method is used here: firstly, quartz glass is coated with photoresist (negative resist AZ4562) by the spin process and then structured by photolithography. A regular pattern of square structures with a side length of 400 µm and spaced 100 µm apart is selected.

After structuring, several of the square areas are free of photoresist while the rest of the glass surface is protected with it. In the first coating process which follows, a bandpass filter system consisting of 18 individual layers with a center wavelength of 400 nm is deposited on the exposed areas. This is a layer stack consisting of alternating low-index and high-index coating material, a so-called high-low stack. The two materials are deposited fully reactively by physical vapor deposition: the high-index material consists of niobium oxide NbO_2, the low-index consists of silicon oxide SiO_2. The total thickness of the filter system lies in the 2 µm range. Finally, following this coating step, to conclude the first lift-off process the photoresist mask is removed in the potassium hydroxide (KOH) bath and the square interference filter structures are left on the surface of the glass. A sheet of glass showing the result of this process can be seen in Figure 1.

This process is repeated another three times: in the second coating step a high-low stack consisting of 15 individual layers with a target wavelength of 475 nm is deposited; in the third coating step a stack consisting of 13 individual layers with a target wavelength of 550 nm is deposited; and finally in the fourth coating step a stack consisting of 11 individual layers with a target wavelength of 625 nm is deposited. The result of this sequence of operations is an uniform arrangement of these different filter systems (see Figure 2).

Outlook

These pixel filters have a great industrial potential. Besides use in the field of hyperspectral and multispectral imaging, future examples of application for the filters will also be found in aerospace and in astronomy. In addition, concepts are already

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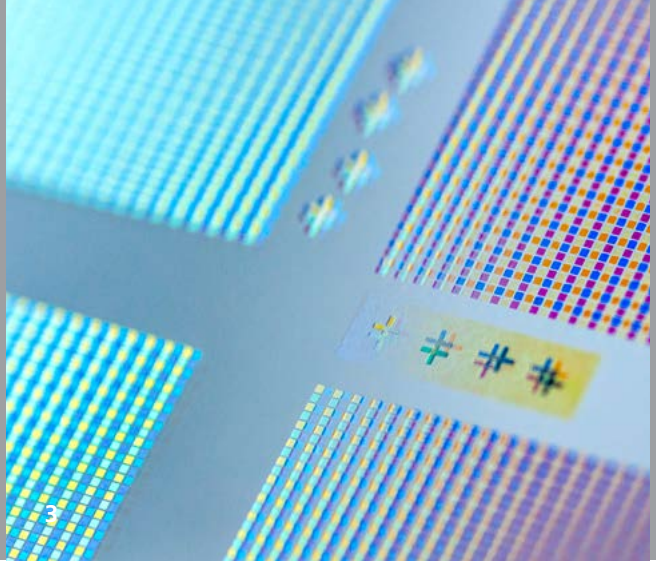

in existence for using imaging metrology to sort waste by material type or for determining the condition of agricultural crops. The Fraunhofer IST is therefore already currently engaged in further development of the pixel filters. This work aims at further reducing the size of the individual pixels, refining the spectral properties of the pixel filter and further simplifying the entire production process, thereby reducing production costs.

The project

The research was conducted within the Fraunhofer's own internal MSE-oriented research project in collaboration with the Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB.

1 *Filter system after the first lift-off process.*

2 *Filter system after the fourth lift-off process.*

3 *Arrangement of several pixel-filter areas on a glass substrate.*

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