NOLOSS
Lossless photon management
Optical design for manufacture at different length scales

Marie Curie Actions

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OPTICAL SYSTEMS BASED ON METASURFACE ELEMENTS

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Project Objective

A metasurface is a two-dimensional arrangement of nanoscale scatterers with capability to alter phase, polarization and amplitude of light [1]. As shown in Fig. 1, such metasurfaces open new possibilities in optical systems with the potential to replace conventional optical components such as:

- microlenses,
- polarizers,
- color filters.

All-dielectric metasurfaces, in contrary to the more known plasmonic ones, provide a reasonable solution towards a lossless optical system, while maintaining the flexibility of controlling the resonances of electric dipole (ED) and magnetic dipole (MD) in the range of visible light [2].

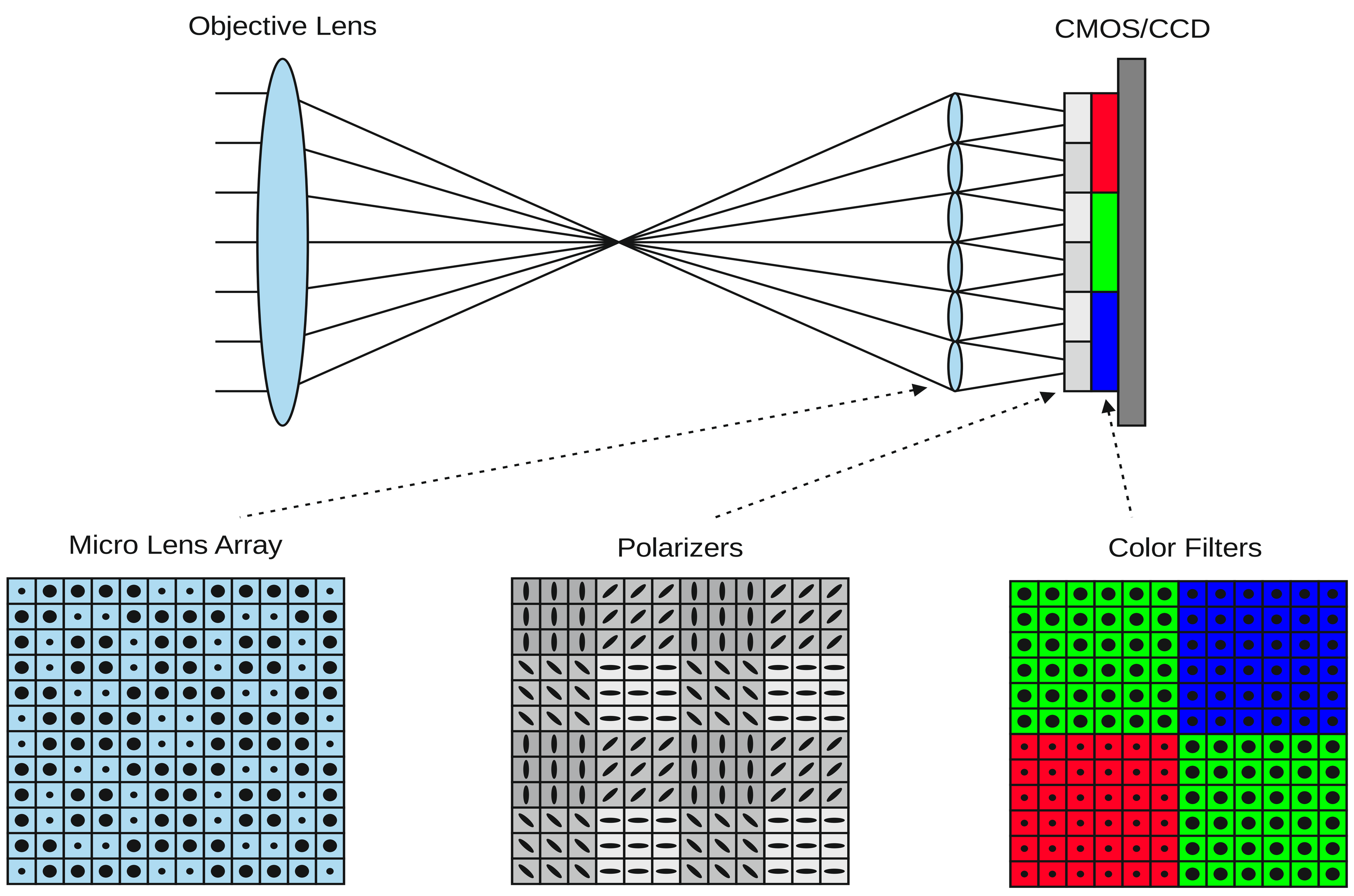

Fig. 1. Schematic representation of plenoptic camera using metasurface elements.

Color Filters

Color filters are designed by tuning the ED and MD resonances by the change of Silicon nanodisk's dimensions: height, diameter, periodicity. The best filter functions for RGB (Fig. 2) can be found directly via sweeps of parameters or can be successfully derived from other color functions, like CMY (Fig. 3).

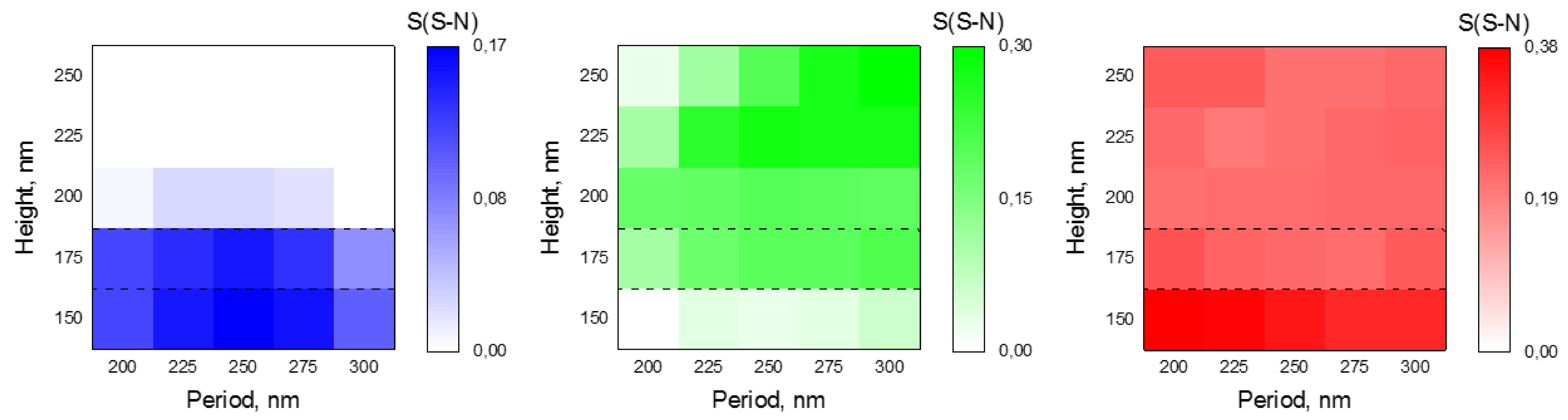

Fig. 2. Parameter sweeps of Silicon nanodisk for the best RGB filter function. At each period-height configuration full diameter sweep takes place until the best signal is found. The dashed lines highlight the constant height at all ranges for optimal manufacturing.

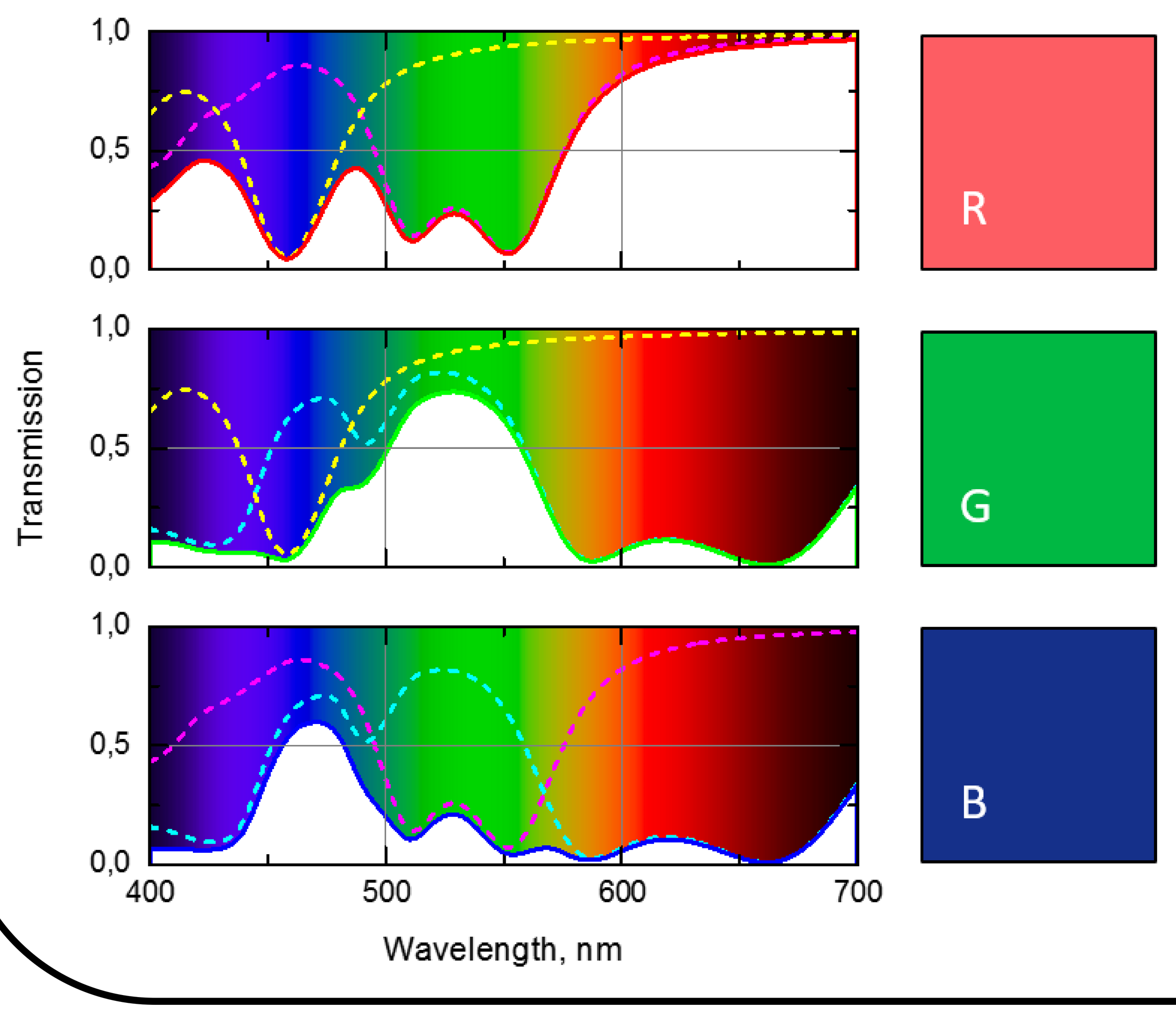

Fig. 3. RGB functions (solid lines) can be computationally derived from other color functions like CMY functions (dashed lines) found by similar parameter sweeps of Silicon nanodisk dimensions. Color representation (right) is shown according in CIE 1931 standard. The levels of RGB reach 90%, 70% and 60% respectively. Similar results can be obtained if the CMY filters would be used in a two layer system.

Polarizers

Structures elongated on one axis (Fig. 4) become polarization dependent, at particular dimensions enabling the metasurface to work as a polarizer (Fig. 5).

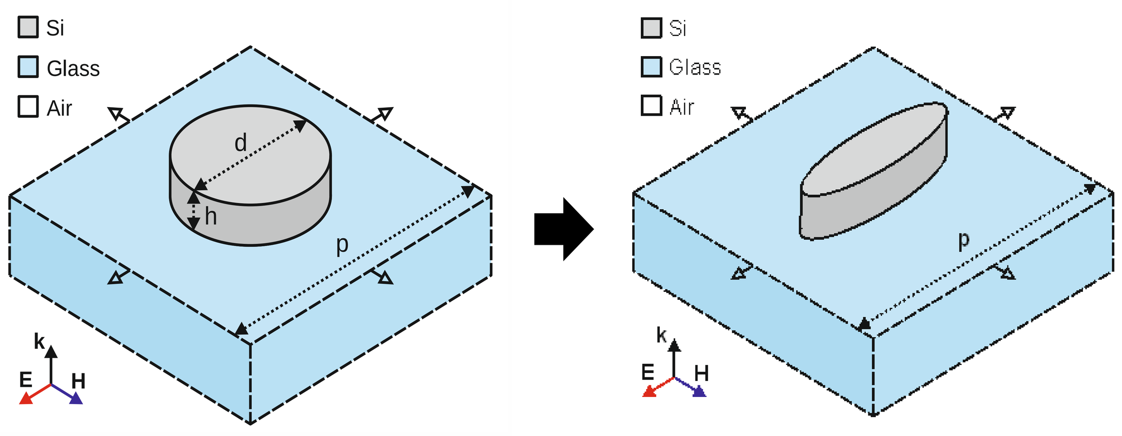

Fig. 4. Transformation from nanodisk to polarization dependent structure.

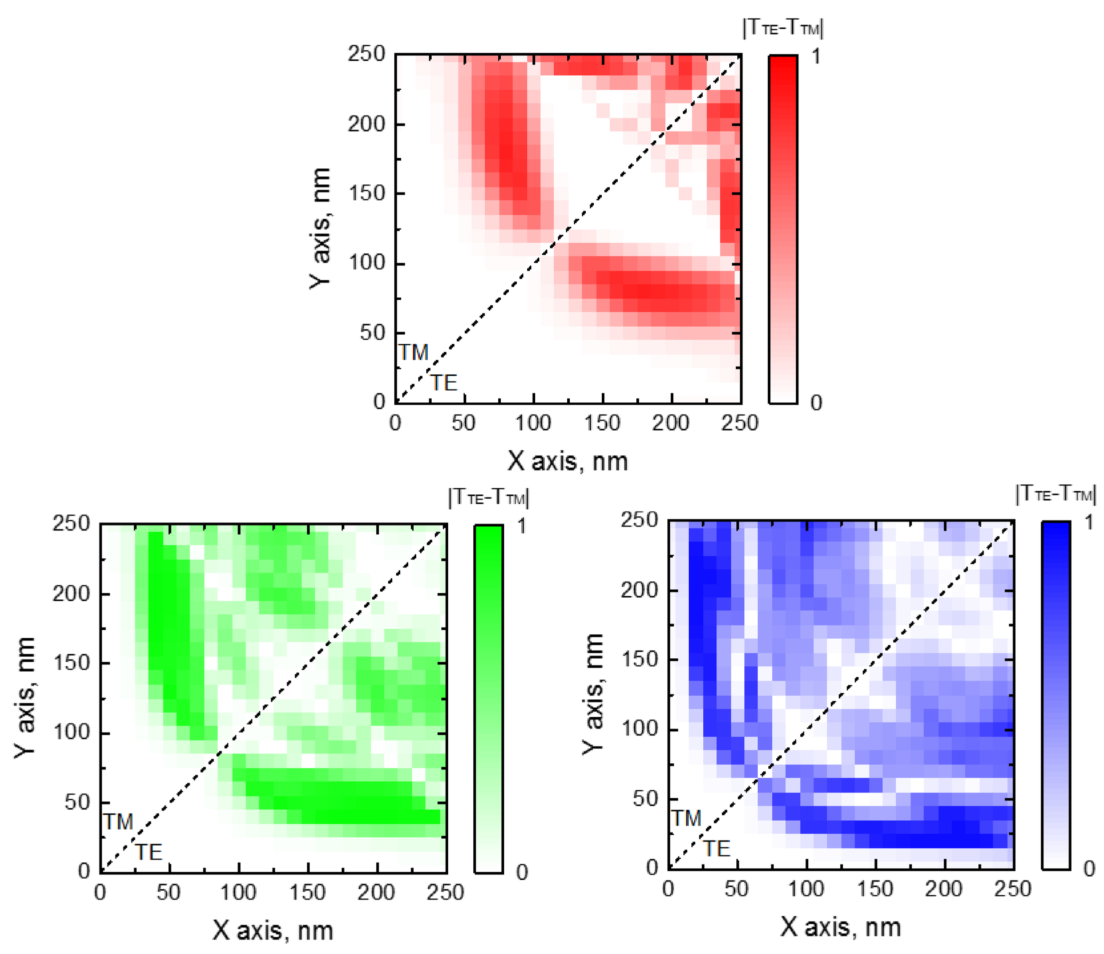

Fig. 5. Polarization sensitivity |TE-TM| dependence on the dimensions of Silicon ellipsis at RGB. The TE and TM polarization are aligned along X axis and Y axis, respectively.

References
[1] S. Jahani, Z. Jacob, *Nature Nanotechnology* 11(1), 2016.
[2] J. van de Groep, A. Polman, *Optics Express* 21(22), 2013.

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