

# Optical Chirality in the Stacked 3D Ring-Split Ring Nanostructure

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## Abstract

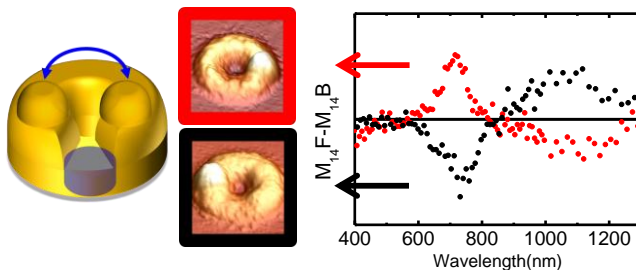
Nanostructures with plasmon enhanced chiral properties have drawn intense interest in the last years due to the potential applications in the detection and even asymmetric synthesis and catalysis of chiral molecules [1]. In the current work we propose experimentally a novel 3-dimensional (3D) nanostructure based on the stacked ring-split ring with an additional dot on top (Figure 1) [2], which performs a sound optical chiral effect in the wavelength range from visible to near infrared.

Hole-mask colloidal lithography (HCL) method is chosen to realize the considered nanostructures over  $\text{cm}^2$  [3]. Meanwhile, the top dot can be easily located along the perimeter of the structure (left in Figure 1), which actually controls the chirality and handedness of the nanostructure. Furthermore, with this method it is possible to insert a ferromagnetic Co dot below the gap, which makes it possible to explore the intertwined magneto-optical and chiral effects or to control the chiral property with magnetic field [4]. Representative AFM images of two structures with complementary handednesses are shown in the middle. Optical characterization is performed by measuring the Mueller Matrix elements of the nanostructures to discriminate the chiral effect from the co-existing optical anisotropy [4]. As an example, we present in Figure 1 the chiral optical responses of two complementary structures.

## References

- [1] V. K. Valev, J. J. Baumberg, C. Sibilia, T. Verbiest, *Adv. Mater.*, 25 (2013), 2517
- [2] H. Feng, F. Luo, R. Arenal, L. Henrard, F. García, G. Armelles, A. Cebollada, *Nanoscale*, 2016, DOI:10.1039/C6NR07864H
- [3] H. Fredriksson, Y. Alaverdyan, A. Dmitriev, C. Langhammer, D. S. Sutherland, M. Zäch, B. Kasemo, *Adv. Mater.*, 19 (2007), 4297.
- [4] G. Armelles, A. Cebollada, H. Feng, A. García-Martín, D. Meneses-Rodríguez, J. Zhao, H. Giessen, *Acs Photonics*, 2 (2015), 1272

## Figures



**Figure 1:** Left: sketches of the proposed 3D nanostructures. The position of the top dot can be controlled in order to tune the chirality of the structure (blue arrows). Middle: representative AFM images of two structures with complementary handednesses. Right: complementary spectra representing the chiral optical responses obtained from the Mueller Matrix elements.