Fluorescence enhancement with metasurfaces structures

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Metasurfaces have been already used for fabrication of flat and lightweight optical components, such as gratings, lenses, beam shapers (holographic phase masks, colour filters, and absorbers) [1]. Furthermore, these types of structures offer the possibility of tailoring the excitation and emission of fluorescent molecules by controlling the light propagation at nanoscale making them suitable candidates for biosensing applications [2].

Here we propose a low-cost metasurface platform consisting of metallic aggregates with random distributions for fluorescence enhancement comparable with results achieved by artificially engineered structures. We investigated the fluorescence emission of Rhodamine 6G (R6G) dispersed in polymethylmethacrylate (PMMA) or ethanol and coated on top of metallic nanoparticles. To better analyse the fluorescent enhancement, we studied three different concentrations of R6G (C1 = 50 μM, C2 = 10 μM and C3 = 5 μM), and three films thicknesses: 230, 190 and 170 nm. The analyzed metals are gold, aluminium and silver, and the substrates employed in this investigation are silicon and glass. The nanoparticles were obtained by e-beam evaporation of either discontinued layers (very thin- 2–4 nm-thick mass equivalent) or continuous layers nanostructured by thermal annealing [3]. Figure 1 show the variation of fluorescence intensity depending on fluorophore deposition characteristics. The best results concerning the fluorescent intensity were obtained when R6G was dispersed in PMMA, the role of PMMA being to protect the fluorophore luminescent properties from degradation when drying in normal atmosphere. Also, the presence of metasurface significantly increases the fluorescence emission. The results demonstrate that we can achieve an intensification of the fluorescence emission for R6G fluorophore up to 423 folds, depending on the geometry and distribution of the metallic nanostructures.

References

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Figures

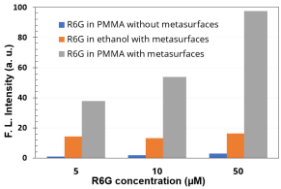

Figure 1: Variation of fluorescence intensity depending on fluorophore deposition characteristics (dispersed in Ethanol or PMMA) w/wo metasurface.

Acknowledgement: This work is funded by the Ministry of Research Innovation and Digitalization through Program 1 - Development of the National R & D System, Subprogram 1.2 - Institutional Performance - Projects for Excellence Financing in RDI, project MicroNEx, Contract no. 20 PFE din 30.12.2021 and CCCDI-UEFISCDI Grant 328/10.08.2020 (project number PN-III-P2-2.1-PED-2019-1300), within PNCDI III.