Leveraging on ENZ Metamaterials to Achieve 2D and 3D Hyper-Resolution in Two-Photon Direct Laser Writing

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In the last years, the interest of researchers is mainly focused on an effective way to improve the resolution of one- and two-photon polymerization with application in different frameworks like photonic circuits, polymeric ridges doped with quantum emitters [1], plasmonic-photonic transistors [2], just to name a few. The continuous research on metamaterials allows designing and predicting the optical behavior of a plethora of systems like hyperbolic metamaterials and optical nano-cavities enabling very exciting features including extraordinary transmittance, zero reflectance and giant dephasing [3,4]. By exploiting a metal/insulator/metal/insulator geometry, an upgrade of the standard two-photon direct laser writing (TP-DLW) process to hyper resolution was enabled [5,11]. The improved technique will play a relevant role in nanotechnology. It can pave the way to fabricate new generation of 2D/3D nanometric devices with intriguing applications, such as nanoparticles in a specific disposition [6], or on flexible substrate producing plasmonic resonance shifts [7] and thermoplasmonic effects [8,9]. The achieved voxel reduction of about 89% in height and the 50% in width enable the fabrication of labels exploiting physical unclonable functions (PUFs) [5,11] or the realization of apochromatic broadband metalenses with extended focal length and a depth of focus with a numerical aperture of 0.87 [10,11]. The improved resolution of TP-DLW process is extremely important for industrial applications in several fields such as anti-counterfeiting and flat optics.

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Biography

Dr. Giuseppe Emanuele Lio received his M.Sc. degree in in Science and Engineering of Innovative and Functional Materials with full marks September 2017 at the University of Calabria (Italy). From April to July 2017 he spent a period of stage/internship at the University of Technology of Troyes, France. He awarded the Ph.D in Physics, Chemistry and Material Science and Technology at University of Calabria and the Nanotechnology Institute (CNR-Nanotec). He published several papers focused on photopolymerization, nano-scale fabrication, numerical simulations, and experimental measurements in optics, photonics and plasmonics. He developed experimental expertises in ellipsometry, micro and nano-fabrication, spectroscopy analysis, and spectrofluorometry. He was invited as Research Scholar in the NanoPlasmLab at the Case Western Reserve University in Cleveland, Ohio, USA. There, he improved his knowledge in gain-materials modeling, and deep machine learning used to design metasurfaces with nano-scale features. Now he his research fellow at the National Institute of Optics-CNR and Eurpean Laboratory for Non-Linear Spectroscopy, LENS at Florence.

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