3D printing for Terahertz absorbers

Polina Kuzhir
Institute of Photonics, Department of Physics and Mathematics, University of Eastern Finland
polina.kuzhir@uef.fi

A brief overview of the work done within Horizon 2020 Graphene 3D project towards THz perfect absorbers made of carbon-based 3D printed architectures is given. A number of strategies are discussed.

High broadband absorption can be achieved by 3D-printed by FDM or stereolithography cellular structures made of a moderately conductive (1–30 S m^{-1}) skeleton. The interplay between characteristic geometrical features (cell size) of those meshes and their conductivity allows to get very good results in very broad ranges of wavelengths [1,2].

Another option is deposition of a thin metal layer onto 3D printed regular array of polymer hemispheres covered with graphene [3]. Tailoring the electromagnetic responses of such metasurfaces could be done by changing the diameter of hemisphere and / or period of the overall structure. Another pattern rather than hemispheres could be also applied successfully, e.g. pillar-type structure.

Perfect tuneable resonant absorption could be obtained by 3D meshes made of highly conductive (1200–2000 S m^{-1}) glassy carbon scafold.

Probably the most interesting case is an array of multi-layered graphene hemispheres made through the combination of 3D ink-jet printing, electroplating and chemical vapor deposition processes. These very thin metasurfaces demonstrate almost perfect absorption, > 95%, in very broad frequency range (100 GHz – 10 THz). They are also robust against macroscopic structural defects, i.e. their electromagnetic properties remain the same when structure comprises up to 40% of randomly distributed holes and other geometrical imperfectness [4,5].

Acknowledgement
This research is supported by H2020 RISE 734164 Graphene 3D project.

References

[1] Polina Kuzhir, et al, Carbon **171**, 484 (2021).
[2] Dmitry Bychanok, et al, Materials **13**, 5208 (2020).
[3] Alesia Paddubskaya, et al, Nanomaterials **11**, 2494 (2021).
[4] Marian Baah, et al, Carbon **185**, 709 (2021).
[5] Andrey Novitsky, et al, Phys. Rev. Applied **17**, 044041 (2022).