BROADBAND OPTICAL LIMITING ACTION OF SOME DEFECT ENGINEERED GRAPHENES

M. Stavrou[1,2,*], A. Stathis[1,2], I. Papadakis[1,2], S. Couris[1,2]

[1] Department of Physics, University of Patras, 26504 Patras, Greece;
[2] Institute of Chemical Engineering Sciences (ICE-HT), Foundation for Research and Technology-Hellas (FORTH), 26504 Patras, Greece
* m.stavrou@iceht.forth.gr

ABSTRACT

Since the discovery of graphene in 2004 [1], intense research efforts have been devoted towards their functionalization and/or modification of their structure, in order to improve, modify and/or tune their opto-electronic properties for specific applications. In that view, different structural modification strategies have been proposed, with the substitutional heteroatom doping being among the most promising ones [2]. Nitrogen atom is among the most promising candidates for the chemical doping of graphene and its derivatives, as it allows for the efficient tuning of the energy bandgap of graphenes, which is of essential importance for various optoelectronic applications. Optical limiting (OL) materials constitute an interesting class of materials which can control/limit the optical power of laser beams, which are employed routinely for several applications nowadays, thus protecting expensive instrumentation/devices and the human eye as well. An ideal optical limiter is expected to exhibit a high transmittance for low-incident fluence (J/m^2) radiations, while it should limit effectively laser radiations exceeding a certain incident fluence, i.e., exhibiting a low onset for optical limiting action. In that view, recently, graphene oxide (GO) [3] and fluoro-graphene (GF) [4] have been shown to exhibit outstanding broadband optical limiting action, while by varying the O- and F-content, respectively, the modification of their sp^2/sp^3 bonding ratio was achieved, allowing for the controlled tuning of their bandgap [5,6,7].

In the same spirit, the present work will discuss recent results regarding the engineering of the defects of GO and GF by means of their heteroatom doping with different N-content GOs (N-GO) and GFs (N-GF) exhibiting very efficient broadband OL performance, ranging from visible to NIR (e.g., 450-2300 nm). The present results demonstrate the power of defect engineering of graphene derivatives for the extension and the tailoring of their OL action in view of potential applications in photonics and optoelectronics.

KEYWORDS: Graphene, Graphene Oxide, Graphene Fluoride, Optical Limiting, Defect engineering

REFERENCES

[1] Novoselov, K. S., Geim, A. K., Morozov, S. V., Jiang, D., Zhang, Y., Dubonos, S. V., Grigorieva, I. V., Firsov, A. A. (2004). *Science* 306 (5696): 666−669.

[2] Panchakarla, L. S., Subrahmanyam, K. S., Saha, S. K., Govindaraj, A., Krishnamurthy, H. R., Waghmare, U. V., Rao, C. N. R. (2009). *Adv. Mater.* 21: 4726−4730.

[3] Marcano, D., Kosynkin, D., Berlin, J., Sinitskii, A., Sun, Z., Slesarev, A., Alemany, L., Lu, W., Tour, J. (2010). *ACS Nano* 4(8): 4806–4814.

[4] Nair, R. R., Ren, W. C., Jalil, R., Riaz, I., Kravets, V. G., Britnell, L., Blake, P., Schedin, F., Mayorov, A. S., Yuan, S. J., Katsnelson, M. I., Cheng, H. M., Strupinski, W., Bulusheva, L. G., Okotrub, A. V., Grigorieva, I. V., Grigorenko, A. N., Novoselov, K. S., Geim, A. K. (2010). Small 6(24): 2877-2884.

[5] Stathis, A., Stavrou, M., Papadakis, I., Obratzov, I., Couris, S. (2020). *Nanomaterials* 10(11): 2319.

[6] Stavrou, M., Papadakis, I., Bawari, S., Narayanan, T. N., Couris, S. (2021). *J.Phys.Chem. C.* 125(29): 16075-16085.

[7] Papadakis, I., Stathis, A., Bourlinos, A. B., Couris, S., *(2020). Nano Select* 1(4): 395-404.