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Graphene-Based Light-Powered Propulsion: a Possible Alternative to Solar Sail

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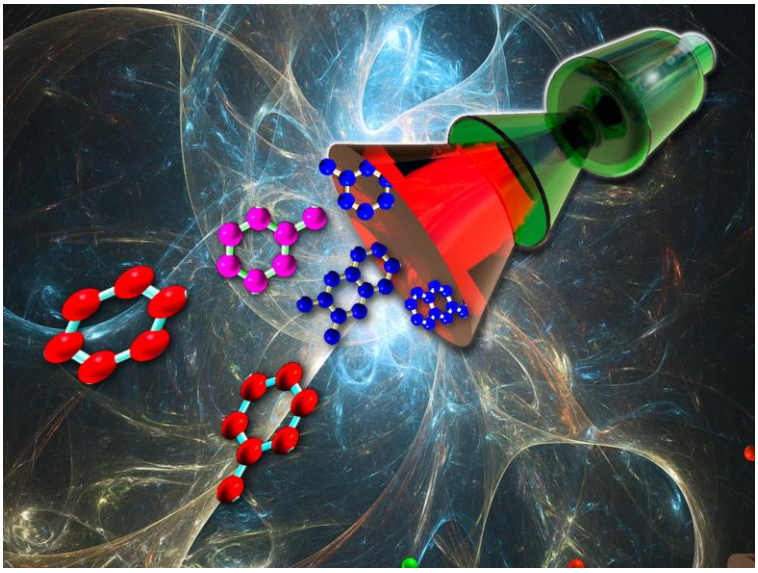

Graphene-based materials hold great promise in advancing fuel-free spacecraft. For instance, graphene sponges created through fusion of crumpled sheets of graphene oxide have been shown to propel forward when illuminated by focused sunlight or lasers of different wavelength and intensity under vacuum. The forward movement experienced by these pieces of graphene sponge exceeded that expected for a solar sail material, where the object propels forward from the momentum transferred from the photons, and was attributed to the absorption of laser energy by the material, which results in a charge build-up and subsequent release as a current flowing away from the material. This suggests that graphene-based light-powered propulsion systems may outperform other solar sail materials. Yet, fabrication of three-dimensional, large area graphene materials with properties arising from the nature of individual graphene sheets remains a significant challenge. Furthermore, these materials should be able to withstand significant compression without loss of optoelectrical properties under extreme environmental conditions expected in space, and ideally not contain any additives that may compromise function or longevity of the 3D material. Here, we will discuss methods presently used for fabrication of high-quality 2D and 3D graphene materials, focusing on plasma-enabled methods of graphene synthesis.

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[2] M. V. Jacob, R. S. Rawat, B. Ouyang, K. Bazaka *et. al,* Catalyst-free plasma enhanced growth of graphene from sustainable sources. *Nano letters* 2015, **15**, 5702-5708.

[3] I. Levchenko, K. K. Ostrikov, J. Zheng, X. Li, M. Keidar, K. B. K Teo, Scalable graphene production: perspectives and challenges of plasma applications, *Nanoscale* **8**, 10511-10527, 2016.