Laser Induced Graphene based Triboelectric Nanogenerators

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Triboelectric nanogenerators (TENGs) have become a popular solution for sustainable energy generation in self-powered electronic devices such as: pacemakers, smart shoes, and electronic skins [1]. Conventional TENGs utilise two or more contacting materials of unique chemical compositions in addition to conductive surfaces which carry the charge generated from the friction between the contacting surfaces. Polymers such as: polyimide, polytetrafluoroethylene, and polydimethylsiloxane are some of the popular polymers which are used to fabricate flexible, reliable, and compact TENGs that can be easily integrated with secondary energy storage sources like capacitors and re-chargeable battery banks. Furthermore, in addition to the dielectric layers, conductive interfaces (i.e., electrodes) play an important role in aiding the charge transfer from the TENG to the measurement apparatus. Graphene is a conductive, reliable, and convenient material which can be easily transferred onto the TENG and utilised as an effective electrode. Recent research has shown that laser induced graphene (LIG) is a useful method to create conductive electrodes on dielectrics for TENGs without the need for additional thick adhesives [2]. Utilising this approach, this study shows that LIG can be utilised to replace traditional conductive adhesives for electrodes on TENGs, to create thin film devices with high surface charge density [208 pC/cm^2] and energy conversion efficiency [over 10 V_{pp}, 50 nA_{pp}] at a low stimulation intensity of 10 N at 0.3 Hz. Furthermore, we also show that this method can also be used to scale TENGs to fabricate foldable, stretchable, and reliable volumetric TENGs composed of multiple frictional interfaces as shown in Figure 1. Therefore, laser abrasion has been shown to be a highly useful tool for scaling TENGs to fabricate superior energy harvesters that can be conveniently integrated with electronic devices for various energy conversion applications.

References

[1] Luo, J. and Wang, Z.L., 2020. Recent progress of triboelectric nanogenerators: From fundamental theory to practical applications. EcoMat, 2(4), p.e12059.
[2] Stanford, M.G., Li, J.T., Chyan, Y., Wang, Z., Wang, W. and Tour, J.M., 2019. Laser-induced graphene triboelectric nanogenerators. ACS nano, 13(6), pp.7166-7174.

Figures

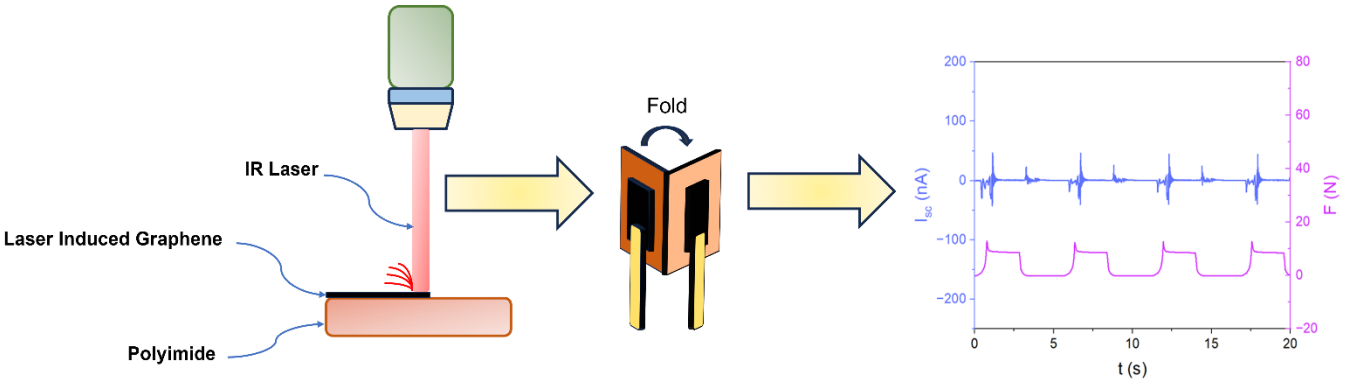

Figure 1: TENG fabrication process using laser abrasion to create LIG based electrodes for energy harvesting applications.