Preparation and Properties of Graphene/PA6 Nanofibers

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Electrospinning is a simple and flexible technique to produce polymer nanofibers in the submicron range for diverse applications in biomedical engineering, wound dressing materials, separation filtration, chemical sensors,etc.[1,2] A wide variety of nanofillers such as montmorillonite,[3]passivated Au nanoparticles[4] and carbon nanotubes[5] have been used to improve the physical properties of electrospun polymer nanofibers. Recently, graphene, a two-dimensional one-atomthick sheet, has emerged as a subject of scientific and engineering interest owing to its amazing properties. These properties and application of graphene in the regulation of electrospinning processes is expected.

Rheology of suspensions

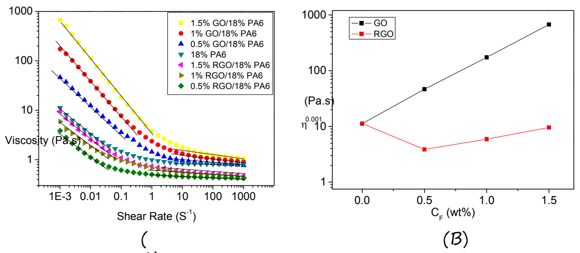

*Figure 1. **(A)**Steady viscosity η as a function of shear rate for PA6 solution (C=18 wt %) and the GO/PA6 and RGO/PA6 suspensions **(B)** Steady viscosity at 0.001 s^{-1} ($\eta_{0.001}$) as a function of nanosheets loading (C_F)*

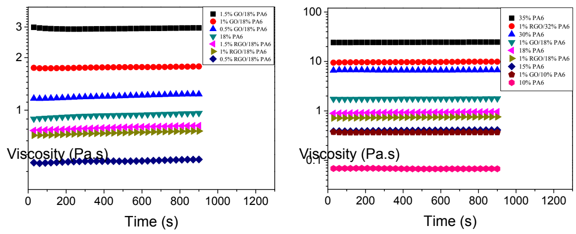

Figure 2. The peak hold curves of various suspensions at 1 s^{-1}

The fundamental factor determining the suspension rheology is total amount of H-bonding between the PA6 chains and between PA6 and the nanosheets (**Fig.3**).This can be applied in electrospinning to broaden the SC window of PA6 (**Fig.4**).

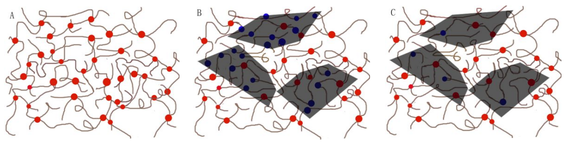

*Figure 3. Schematic descriptions of microstructures of **(A)** PA6 solution and **(B)** GO/PA6 and **(C)** RGO/PA6 suspensions [intra-chain H-bonding among PA6 macromolecules: red dots; H-bonding between nanosheets and PA6 chains: blue dots]*

Morphology and properties of nanofibers

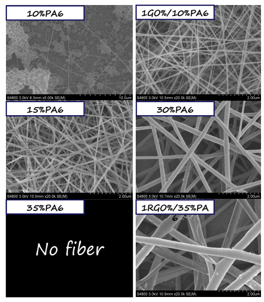

Figure 4. SEM image of PA6 nanofibers electrospun at different concentration and nonafibers with GO and RGO.

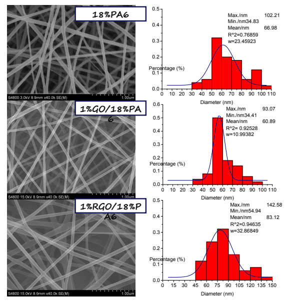

Figure 5. SEM image of nanofibers and its diameter distribution histogram

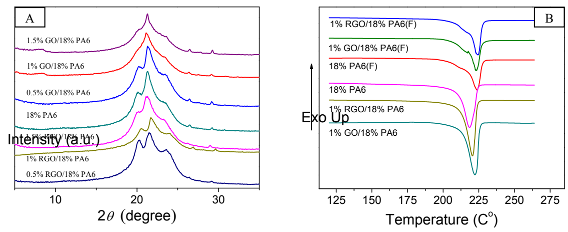

*Figure 6. **(A)** XRD patterns and **(B)** DSC curves of PA6 and its GO and RGO composite nanofibers*

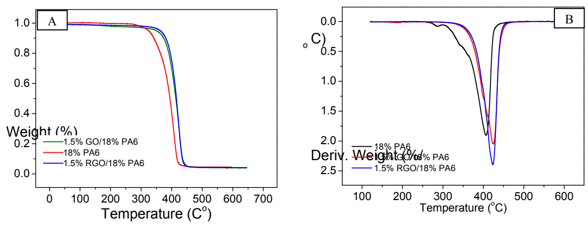

*Figure 7. **(A)** TGA and **(B)** DTG curves of PA6 and its GO and RGO composite nanofibers*

Conclusions

- ◘A small amount of GO and RGO result in increase and decrease in steady viscosity of PA6 suspensions, and this is driven by H-bonding;
- ◘GO and RGO sheets significantly broaden the SC range of PA6;
- ◘GO sheets favor the formation of γ-phase crystal in composite nanofibers, while RGO sheets inhibit it;
- ◘GO and RGO sheets can dramaticlly improve the thermal stability of composite nanofibers.

References

[1] D. Li and Y. Xia,Adv. Mater., 2004, 16, 1151.
[2] Y. Ding, Y. Wang, L. C. Zhang, H. Zhang, Nanoscale, 2011, 3, 1149-1157.
[3] H. W. Lee, M. R. Karim, H. M. Ji, J. H. Choi, H. D. Ghim, S. M. Park, W. Oh and J. H. Yeum,J. Appl. Polym. Sci., 2009, 113,1860–1867.

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