CONDUCTIVE GLASS FIBER COATED WITH GRAPHENE PREPARED BY DIP COATING METHOD

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ABSTRACT

We report a simple method to prepare graphene coated glass fiber in this work. Continuous and compact graphene coating was successfully obtained on glass fiber via dip-coating. Various coating times have been studied for the morphology of the graphene coating, and their dynamic contact angle and resistivity have also been investigated. The electrical conductivity of the composites was influenced by coating times. Such graphene coated glass fibers performed fine conductivity, with volume conductivity of approximately 10 S/cm.

1 INTRODUCTION

Glass fiber was widely used in industrial production due to its low cost and high strength. However, static electricity is easily generated and accumulated on surfaces of insulated glass fiber, greatly hindering application of glass fibers in many fields. Hence, fabrication of conductive glass fiber in a simply way is critical for enlarging applications of glass fiber. Graphene, as a 2D material, has attracted much attention due to its excellent properties, one of which is high electrical conductivity. Therefore, coating graphene on the surface of glass fiber might be an effective approach to make it electrical conductive for eliminating static electricity.

In this work, glass fibers with uniform graphene layers on the surface were obtained by dip coating method. We used dip coating in a continuous process to coat glass fibers with thin graphene film, which was produced from graphene oxide (GO) hydrosol precursor. Once one graphene layer on GF surface is formed after drying, another graphene layer was coated on the surface with another dip-coating process. In this way, we constructed a multi-layer graphene films stacked on the surface of glass fiber.

2 EXPERIMENTAL

Aqueous suspensions of GO at concentration of 0.5 mg/ml was prepared by Hummer's method. Then 80% hydrazine hydrate at 0.5% (in volume) was added. The mixed suspension was heated at 50 ℃ degree centigrade for 4 h without stirring to form RGO hydrosol.

Before the preparation of RGO-GF, the glass fiber was treated at 180 ℃ for 2 h to eliminate the organic remnant. Then the GO hydrosol was coated on this glass fiber monofilament via a continuous dip-coating process (Figure 1), at a speed of approximately 0.25 m/s. The coating times varied from 1 to 20, and the samples were marked as RGO-GF1 to RGO-GF20, respectively.

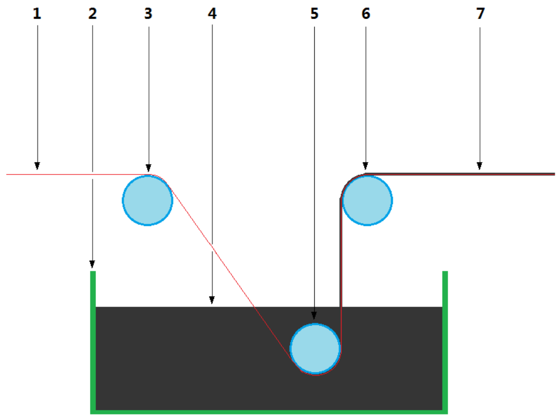

Figure 1: The scheme of the continuous dip-coating equipment.

3 RESULTS AND DISCUSSION

3.1 The morphologies analysis

The morphology of naked glass fiber and various graphene-coated glass fiber samples were investigated by SEM (Figure 2). The surface of the fibers became rough and uneven as graphene coated on. It was found that the average thickness of single layer graphene film was about 500 nm.

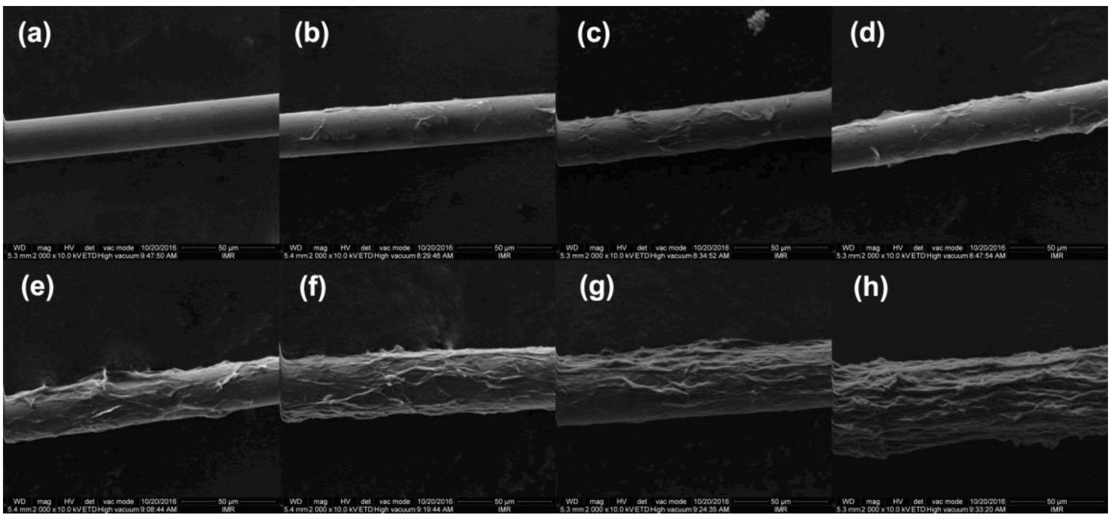

Figure 2: SEM image of the samples: (a) naked glass fiber; (b) 1 graphene coating process; (c) 2 graphene coating process; (d) 3 graphene coating process; (e) 5 graphene coating process; (f) 10 graphene coating process; (g) 15 graphene coating process and (h) 20 graphene coating process.

The RGO/GF was constructed in terms of the mechanism showed in Figure 3. In dip-coating process, a uniform wet gel film can be attached onto the surface of the substrate. Then the coating shrinks during the drying course of gel.

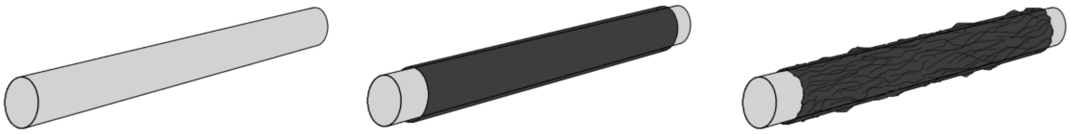

Figure 3: Fabrication of the RGO coated glass fiber.

3.2 Contact angle

Figure 4 is the contact angle of the composites against water, showing that the surface of the fiber has been changed from hydrophilic to hydrophobic. The result provided the evidence that the surface condition has completely changed. The initial contact angle of glass fiber is 23 °to water. As graphene coated on, the data raised rapidly at first. When the coating time is more than 5, the curves became flat. We can consider the surface of glass fiber is wholly covered after 5 coating process.

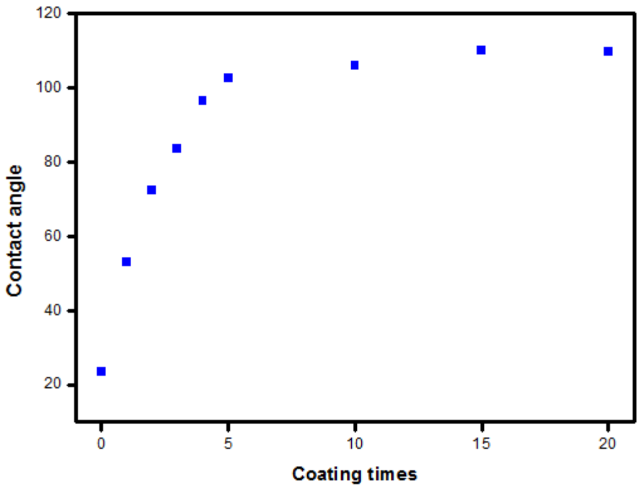

Figure 4: The contact angle of the composites against water.

3.3 Raman spectra

Raman spectra (Figure 5) show that the GO on the glass fiber has been reduced as the formation of GO hydrosol, leading to the improvement of electrical conductivity. It was found that the quality of the coating was influenced by the times of coating process.

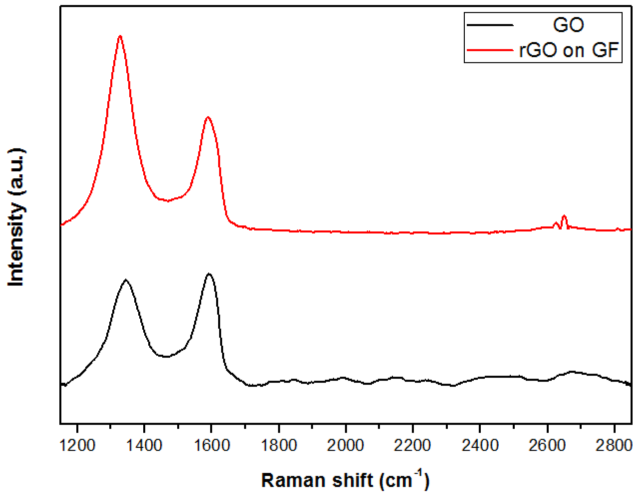

Figure 5: Raman spectra of GO and reduced graphene oxide on glass fiber.

3.4 Electrical resistivity

The current-voltage (C-V) curve (Figure 6) shows that the resistance of the composites is linear, and the volume electrical conductivity could reach to about 10 S/cm.

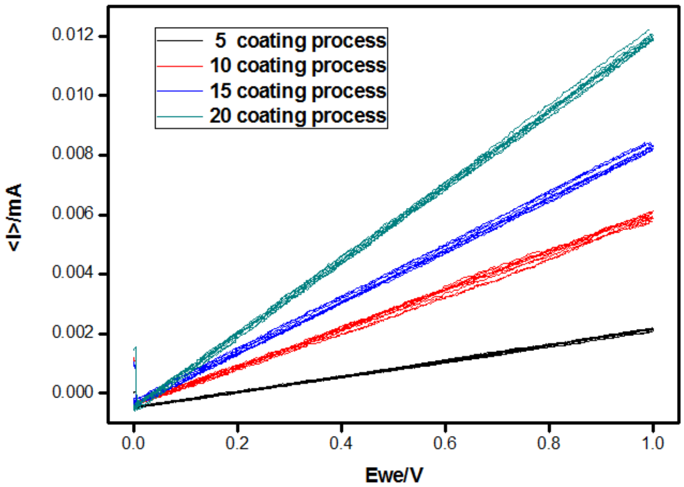

Figure 6: CV curve of different samples of the graphene/glass fiber composites.

4 CONCLUSION

In summary, a continuous and compact graphene film was successfully coated on the surface of glass fiber via dip-coating method. The thickness of the graphene coating was influenced by coating times. Such graphene coated glass fibers performed fine conductivity.

The graphene-coating glass fibers may have some potential applications in many fields. These multifunctional glass fibers with excellent conductivity would eliminate the potential risk of electrostatic in the application of glass fiber and expand its application such as shielding materials, electronic sensors.