

Study on surface modification of recycled carbon fiber to improve interfacial bonding strength with thermoplastic resin

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In this study, carbon fibers recovered from waste carbon composites were subjected to chemical desizing, surface treatment, and resizing (Fig.1) for the purpose of upcycling, and the changes in mechanical and chemical properties of carbon fibers and mechanisms of oxygen functional group according to surface treatment conditions were identified.

For chemical and thermal desizing [1], chemical, thermal, and mechanical properties were analyzed according to the treatment conditions, and for surface treatment [2], FE-SEM, UTM, FT-IR, XPS, BET, and IFSS were performed to evaluate the properties according to the treatment conditions. In addition, during resizing, change of weight, FE-SEM, TGA, AFM, FT-IR, XPS, and IFSS were used to analyze changes in properties according to the concentration and processing time of the resizing agent. In the case of desizing, the sizing agent was completely removed by treatment with acetone for 0.5 h at 60 °C. At this time, the oxygen of the sizing agent was removed from the surface of the carbon fiber, and the oxygen functional group decreased. During surface treatment after desizing, treatment with nitric acid at 100 °C for 1 hour was the optimal condition in which the oxygen functional group and the interfacial bonding strength with PA6 significantly increased without changing the tensile properties compared to the carbon fiber before surface treatment (Fig.2). In the case of resizing, at a concentration of 1 wt.% of the PA6-based sizing agent and a treatment time of 10 seconds, 1 % of the sizing agent was coated on the surface of the carbon fiber, and the oxygen functional group and interfacial bonding strength were also at their maximum.

The results of this study showed that surface treatment of carbon fibers exhibited mechanical/thermal/chemical properties equivalent to or better than commercial carbon fibers. Afterwards, we plan to compare and evaluate mechanical properties by manufacturing carbon composite materials by impregnating surface treated recycled carbon fiber under optimal conditions with thermoplastic resin.

Keyword: Recycled carbon fiber, Desizing, Surface Treatment, Resizing, Interfacial bonding strength, Oxygen functional group

References

1. D. Eyckens, C. Arnold, Z. Simon, T. Gengenbach, J. Pinson, Y. Wickramasingha, L. Henderson, Covalent sizing surface modification as a route to improved interfacial adhesion in carbon Fibre-epoxy composites, *Composites Part A: Applied Science and Manufacturing*, volume 140, 106147 (2021)
2. V.H. Martínez-Landeros, S.Y. Vargas-Islas, C.E. Cruz-González, S. Barrera, K. Mourtazov, R. Ramírez-Bon, Studies on the influence of surface treatment type, in the effectiveness of structural adhesive bonding, for carbon fiber reinforced composites, *Journal of Manufacturing Processes*. 39, 160–166 (2019).
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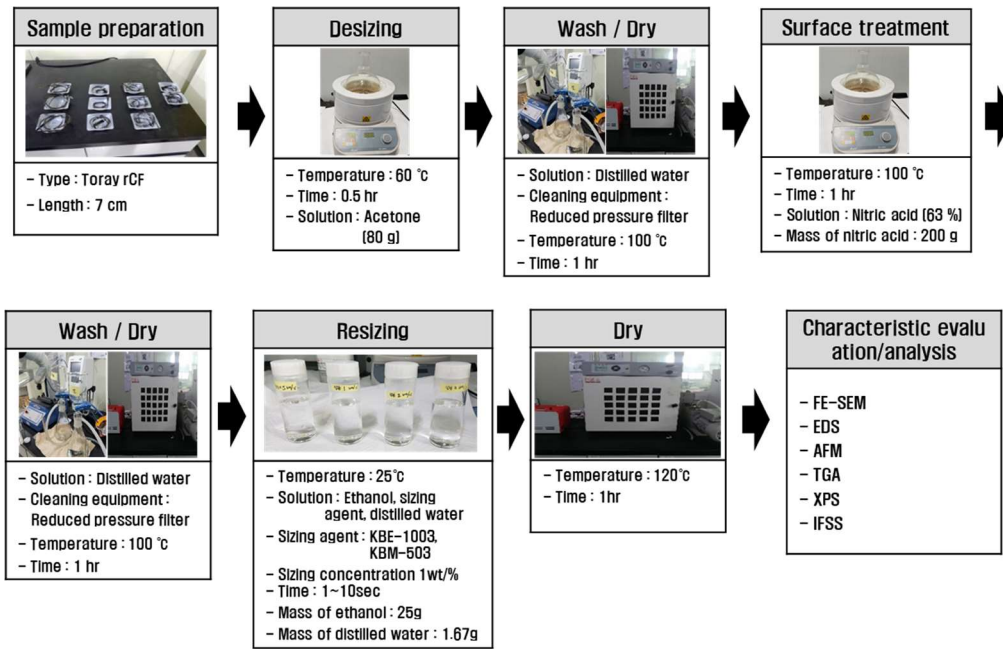


Figure 1. Experimental procedures for desizing, surface treatment and resizing treatment.

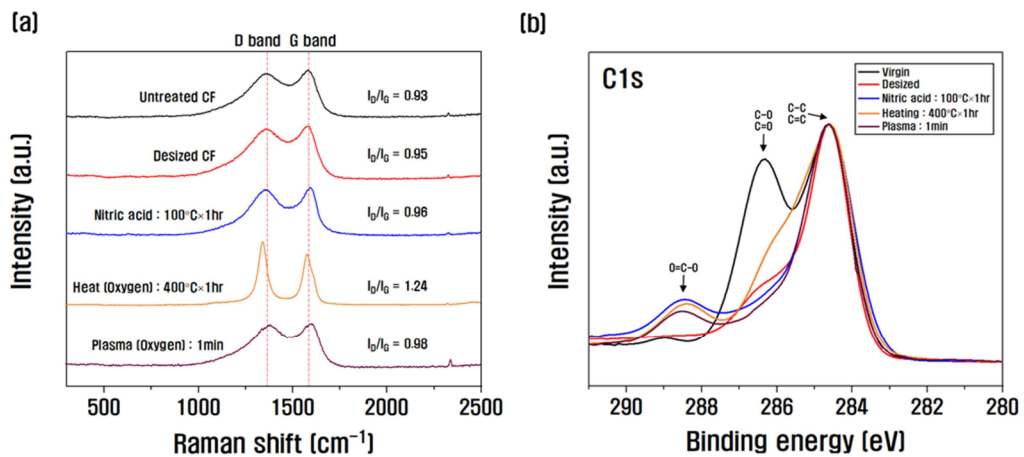


Figure 2. Raman spectra, and C1s X-ray photoelectron spectra of carbon fiber subjected to desizing and surface treatment under different conditions: (a) Raman spectra; (b) X-ray photoelectron spectra.