Carbonization, Activation, and Characterization of Black Liquor-extracted Lignin/Phenolic Resin Mixture: Effect of Exfoliated Graphene Nanoplatelets

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Abstract

Lignocellulosic material such as lignin, hemicellulose and other extractives are considered as promising biomass with low cost and eco-friendliness [1]. They are dissolved into black liquor, which is industrial waste of kraft pulping process. Among them, lignin can also be extracted from black liquor. Lignin exhibits good thermal stability and higher carbon yield than other natural polymers. Lignin has some potential as a precursor material for activated carbon through carbonization and activation processes. Phenolic resin has good thermal stability and high carbon yield. Once the extracted lignin mixes with resole-type phenolic resin, the thermal stability and carbon yield of lignin can be increased. Exfoliated graphene nanoplatelets (xGnP) have several layers of graphene sheets with high aspect ratio. The xGnP have been incorporated into various materials to improve the electrical, thermal and mechanical properties of composites [2]. In this study, the effect of xGnP incorporation in black liquor-extracted lignin and cured phenolic resin mixture on the characteristics of steam-activated carbon is investigated. Lignin, phenolic resin and xGnP were uniformly mixed by physical stirring in methanol, as shown in Figure 1. 1 and 5 wt% xGnP were added to the lignin/phenolic mixture (50/50 wt%). The mixture was cured, finely crushed, and then air-dried to obtain fine powder. Carbonization and steam-activation processes were performed, respectively. The carbonized lignin/phenolic without and with xGnP were characterized by using ATR-FTIR, SEM, TGA, and XRD. The specific surface area and pore size of carbonized and activated products were examined by BET analysis. Figure 2 shows SEM images of the steam-activated carbon in the absence and presence of xGnP.

References

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Figure 1: Preparation procedure of lignin/phenolic/xGnP mixture

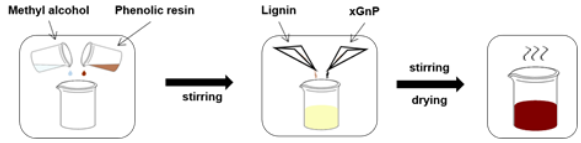

Figure 2: SEM images of lignin/phenolic based activated carbon without and with xGnP.