Improved Graphitization of Lignin by Templating Using Graphene Oxide Additives

*S. Ike and R. Vander Wal

Techniques to improve graphitization of lignin, the second most abundant natural polymer, are in great demand as a viable means to obtain cost-effective and less energy intensive graphite for various applications. In this work, the effect of two-dimensional nanomaterials, graphene oxide (GO) and its derivative, reduced graphene oxide (RGO) are used as templating agents for graphitization of alkali derived lignin. Lignin was first mixed with GO and RGO materials and stabilized at 200°C. The samples were then subjected to a carbonization heat treatment at 500℃ for 5 hours followed by high heat treatment (HTT) at different temperatures: 1000℃, 1500℃ and 2500℃. The hypothesis is that during HTT, the GO additives promote lignin molecules to align on its basal planes via π–π interactions during graphitization (physical templating) in addition to forming reactive radicals from decomposing oxygen groups that provide further bonding sites for lignin molecules during carbonization (chemical templating). X-ray Diffraction analysis of 2500℃ heat treated samples shows larger crystallite size (La) and crystallite height (Lc) values for lignin-GO and lignin-RGO compared to pure lignin signifying improved graphitic quality caused by the proposed templating effect of the GO additives. This was further confirmed by Raman spectroscopic analysis wherein lignin-GO and lignin-RGO had lower D band intensity and thus higher graphitic content, consistent with XRD results. Overall, this work shows a conversion of lignin into large graphitic crystallites that can be valuable for energy storage applications and potentially a promising pathway for carbon materials from renewable resources.