Preparation of cost-competitive isotropic pitch precursors for carbon fiber through a modified oxidative thermal treatment of petroleum residue

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We introduce a modified oxidative thermal treatment as an cost-competitive way to produce spinnable isotropic pitch from petroleum residue. Pyrolysis fuel oil (PFO) was used as a starting petroleum residue, and it was thermally treated under the presence of O_2/N_2 mixed gas. The effects on softening point, pitch yield, and spinnability were investigated with varying O_2 concentration from 0% to 50%. The resultant pitch precursors were analyzed via MALDI-TOF-MS, FTIR, and ^{1}H- and ^{13}C-NMR. It was found that the modified oxidative treatment was highly effective at increasing softening point while maintaining high pitch yield by facilitating thermal condensation and suppressing volatilization of light components. It was possible to increase softening point from 130 to 249 °C with insignificant loss of pitch yield, which was crucial for typical thermal pitch synthesis. Furthermore, they showed excellent spinnability during the melt-spinning process with no fiber breakage longer than 5 min. After isothermal stabilization at 210 °C for 15 h and carbonization at 1100 °C for 1 h, the obtained carbon fibers showed tensile strengths of about 800 MPa, which was comparable to that of a commercial isotropic-pitch-derived carbon fiber. The current study showed that the modified thermal treatment is highly useful for the preparation of cost-competitive pitch precursors suitable for carbon fiber production.