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Experimental Investigation of Chemically Activated Pine Wood Char Gasification at High Pressures Using Tunable Diode Laser Absorption Spectroscopy

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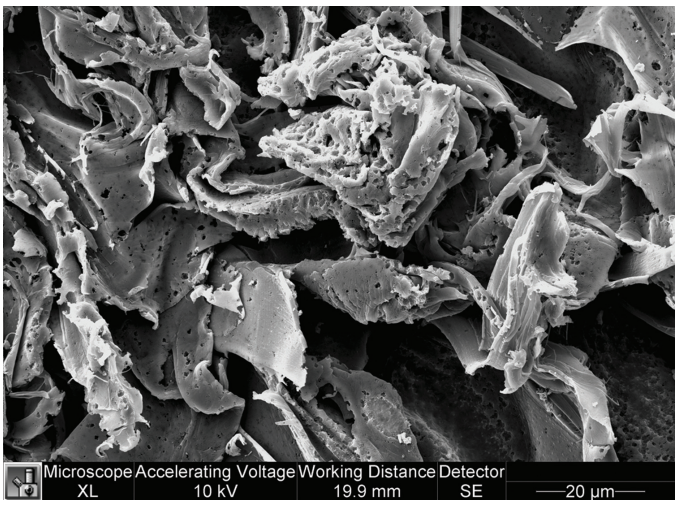
Biomass and coal gasification is a rapidly developing technology due to the increasing global demand for fossil fuel resources. Gasification is the process of conversion of solid carbonaceous feedstock to a gas mixture containing CO and H_2 in the presence of steam or carbon dioxide. Past research on coal gasification has shown that the process requires high temperatures (> 800 °C) and produces large quantities of CO_2 emissions. These two drawbacks make the coal gasification process inefficient and potentially unsustainable in the long term. Current research in gasification technology replaces coal with biomass feedstock. Biomass is an attractive carbonaceous feedstock since it has better low-temperature reactivity than coal and can be carbon neutral. However, the variations in organic matter content, mineral content, size, shape, and microstructure of different biomass feedstock prohibit the generalization of chemical reaction rates. Therefore, a library containing chemical reaction rates for different feedstock is necessary. This study focuses on the gasification reactivity of a low ash pine wood char in the presence of CO_2 at 1000–1270 K and 0.10–1.0 MPa. The gasification progress is tracked by in situ tunable diode laser absorption spectroscopy and corroborated by traditional product gas composition analysis. The impact of chemical activation on the gasification reactivity by treating the pine wood char with NaOH and KOH will be investigated in following experiments. Initial results show that the gasification reaction is kinetically controlled at 1000 K, resulting in little conversion. The gasification reactivity attains a maximum between 40–50% conversion. Gasification at 1100 and 1270 K shows competition between kinetic control and diffusion control. The fundamental chemical kinetic constants are calculated based on the experimental data.

Research advisor Jay Gore writes, "Weichao Wang gained significant knowledge regarding assembly of a high-pressure, optically accessible gasifier apparatus and utilized flow, pressure, temperature sensors, tunable diode lasers, gas chromatography, and Fourier transform infrared radiation (FTIR) spectroscopy in running the gasification experiments. He is a coauthor of two archival journal papers and has received a fellowship to continue his graduate studies."



Scanning electron microscope micrograph of remaining char and ash from gasification at 1100 K.

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