Laser-induced hydrogen generation from coal

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This study presents a simple way of obtaining hydrogen gas from various ranks of coal, coke, and graphite using nanosecond laser pulses under different conditions such as water, air and argon atmosphere. Coal samples were initially characterized by scanning electron microscope (SEM), Fourier transform infrared (FTIR) spectroscopy, and calorimeter. It was observed that 532 nm laser pulses were more effective than 1064 nm pulses in gas generation and both were nonlinearly correlated with respect to the laser energy density. Gas chromatography measurements indicate that mainly hydrogen and carbon monoxide were generated. The hydrogen to carbon monoxide ratio shows that the highest efficiency rank was anthracite coal, with an average ratio of 1.4 due to its high fixed-carbon content and relatively high hydrocarbon amount. Graphite was used as a pure carbon source to study the possible reactions of gas yielded during the irradiation process. In addition, theoretical simulations using a standard finite difference method supported experimental observations. The possible mechanisms of gas generation were explained with chemical reactions. The amount of hydrogen production using laser pulses might be enough to power devices where relatively small amounts of hydrogen are needed.