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Carbothermic reduction of hot rolling sludge by rice husk char with microwave heating

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The scale generated in the hot rolling process is a high-grade iron source. Fine scales are separated in a thickener and discharged as sludge in a slurry state, and they are difficult to use. This study focused on the sludge recycling through carbothermic reduction using microwave heating. Microwave heating occurs when an object absorbs microwaves. Compared to conductive heat transfer, microwave heating allows for internal heating, making it effective for heating fine powders with low thermal conductivity. To achieve carbon neutrality, the carbothermic reduction behavior was investigated using biomass-derived carbon.
For the experiment, the industrial sludge, rice husk char as biomass and reagent-grade graphite were used. The sludge had a composition of T. Fe = 64.1 wt% and FeO = 36.2 wt%. The biomass was obtained by pyrolyzing rice husks at 500℃, containing 43.2 wt% carbon and 47.7% SiO_2 as the main impurity. The biomass or graphite and sludge were mixed in a mol ratio the carbon and oxygen content in the sludge matched C/O = 1. Microwave heating was carried out with 2.45GHz multi-mode iraddiation with magnetron under a nitrogen atmosphere. The total heating time was 20 minutes, with a maximum output intensity of 1050W. The samples were heated from room temperature to degree C and then maintained at that temperature. After heating, the formation of metallic iron was confirmed in both samples. During microwave heating, the sample using biomass took longer to stabilize at 1200 degree C compared to the graphite. It seems due to the SiO_2 in the biomass not absorbing microwaves. SEM-EDS analysis on the reduced samples confirmed the presence of metallic iron and residual FeO in both samples. Additionally, in the biomass sample, large amount of silicate slag containing iron oxides was observed.

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