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Microwave Heating and Catalytic Activity of Iron/Carbon Materials for H_2 Production from the Decomposition of Plastic Wastes

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Abstract : The non-biodegradable plastic wastes have posed severe environmental and ecological contaminations. Numerous technologies, such as pyrolysis, incineration, and landfilling, have already been employed for the treatment of plastic waste. Compared with conventional methods, microwave has displayed unique advantages in the rapid production of hydrogen from plastic wastes. Understanding the interaction between microwave radiation and materials would promote the optimization of several parameters for the microwave reaction system. In this work, various carbon materials have been investigated to reveal microwave heating performance and the ensuing catalytic activity. Results showed that the diversity in the heating characteristic was mainly due to the dielectric properties and the individual microstructures. Furthermore, the gaps and steps among the surface of carbon materials would lead to the distortion of the electromagnetic field, which correspondingly induced plasma discharging. The intensity and location of local plasma were also studied. For high-yield H_2 production, iron nanoparticles were selected as the active sites, and a series of iron/carbon bifunctional catalysts were synthesized. Apart from the high catalytic activity, the iron particles in nano-size close to the microwave skin depth would transfer microwave irradiation to the heat, intensifying the decomposition of plastics. Under microwave radiation, iron is supported on activated carbon material with 10wt.% loading exhibited the best catalytic activity for H_2 production. Specifically, the plastics were rapidly heated up and subsequently converted into H_2 with a hydrogen efficiency of 85%. This work demonstrated a deep understanding of microwave reaction systems and provided the optimization for plastic treatment.

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