

CATALYSIS

Microwaving coke

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Many industrial petrochemical reactions proceed over catalysts based on porous aluminosilicates known as zeolites. Examples include fluid catalytic cracking, which is used to convert long-chain hydrocarbons in crude oil into shorter-chain molecules found in petrol, and methanol-to-hydrocarbons (MTH) technology that can be used to convert non-crude oil carbon sources, such as biomass, into liquid fuels. In catalysing these reactions, zeolites often suffer from deactivation associated with the build-up of hydrocarbon side-products (coke) that deposit on the catalytically active sites. Characterising the coke that forms is important to understanding and mitigating the catalyst deactivation. However, existing spectroscopies used to interrogate the coke have drawbacks related to the limited sample volume probed, inadequate beam penetration, and a lack of sensitivity to certain forms of coke. Addressing this issue, Tiancun Xiao, Peter Edwards, and colleagues in the UK and Saudi Arabia present a microwave cavity perturbation method to examine the type and quantity of coke produced in zeolites catalysing the MTH reaction.

The researchers measure the dielectric properties of the coked catalysts by positioning the sample in an electric field that is generated inside a microwave resonant cavity. The dielectric loss value, normalised by the weight of coke formed (measured by the weight loss when the coked catalyst is burned), provides a unique identifier for various types of coke that can be deposited, which include conjugated olefins, polyaromatics and even highly dehydrogenated molecules consisting largely of sp^2 carbon atoms often not picked up by nuclear magnetic resonance methodologies. Measurements take milliseconds to perform and the technique is non-invasive and fully penetrates the sample, allowing the coke that is contained deep within the porous structure of the catalyst to be probed.

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