Efficient photothermal CO_2 methanation over NiFe alloy nanoparticles

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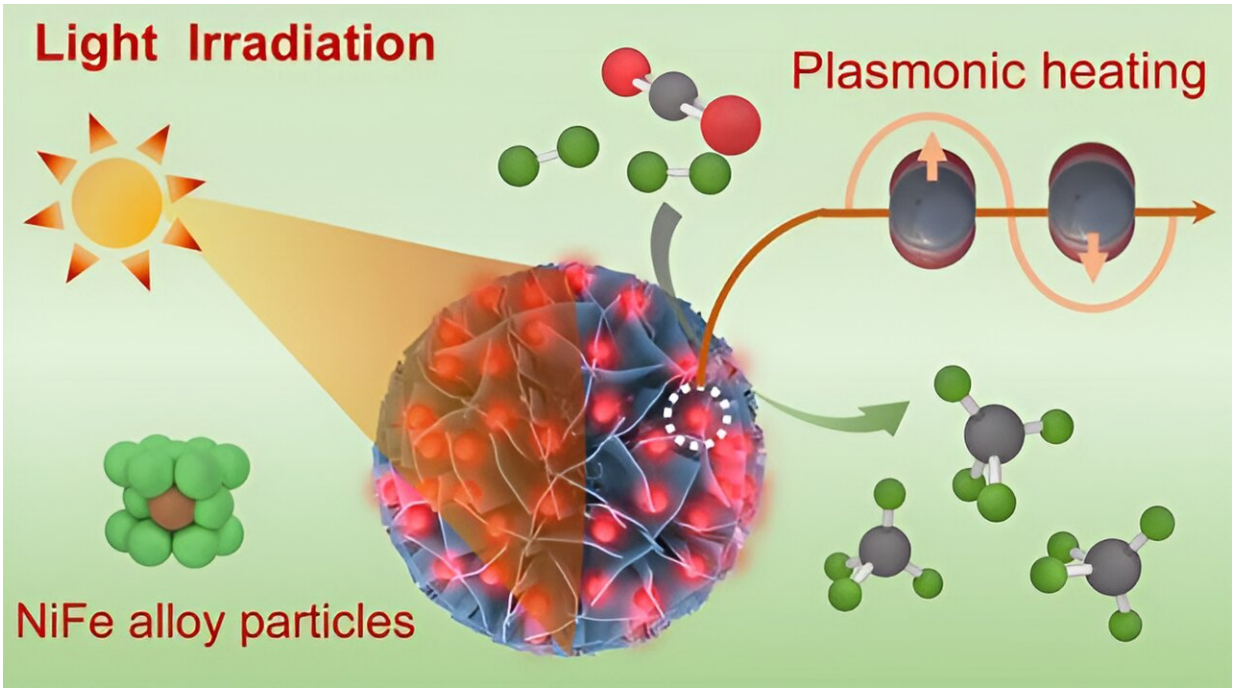

The enhanced LSPR effect on NiFeAl for effective photothermal catalysis of CO_2 methanation. Credit: Science China Press

The massive emissions of CO_2 from the utilization of fossil fuels have caused a series of environmental issues and climate change. Driven by the fast development of green hydrogen and CO_2 capture technologies, the hydrogenation of CO_2 to hydrocarbon fuels and chemicals is becoming a promising process for the reduction of carbon footprint and

the storage of renewable energy. Photothermal catalysis enables efficient CO_2 conversion under mild conditions.

A study led by Prof. Kang Cheng (College of Chemistry and Chemical Engineering, Xiamen University) and Prof. Ye Wang (College of Chemistry and Chemical Engineering, Xiamen University) evaluated catalysts using a high-pressure fixed-bed reactor quartz reactor with a square cavity in the middle to introduce light. The study is published in the journal *Science China Chemistry*.

A series of NiFe alloy photothermal catalysts were synthesized using the urea-assisted precipitation method for CO_2 methanation, in which the bimetallic NiFe nanoparticles with Al_2O_3 as the structural promoter and Ni/Fe atomic ratio of 7 had the best catalytic performance.

The CO_2 conversion rate can reach 98%, the CH_4 selectivity is 99% without external heating. The catalyst can operate stably for more than 100 hours. Compared with other catalysts, it was found that the small alloy particle size (~21 nm) and the unique layered structure of the NiFeAl catalyst could enhance the LSPR effect of NiFe alloy.

Compared with Ni or Fe, NiFe alloys can promote CO_2 methanation synergically. The temperature on the surface of the catalyst was detected to be as high as 356 °C under light irradiation observed by an infrared camera, indicating that the catalyst was able to efficiently convert light energy into heat energy.

This paper not only prepared an efficient catalyst for CO_2 methanation but also provided the idea for the structural design of a photothermal catalyst.

More information: Jiarong Li et al, Efficient photothermal CO2 methanation over NiFe alloy nanoparticles with enhanced localized

surface plasmon resonance effect, *Science China Chemistry* (2023). DOI: 10.1007/s11426-023-1876-4

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