Applied surface science

The ultrasonication boosts the surface properties of CoFe2O4/C nanoparticles towards ORR in alkaline media

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Abstract

Since ultrasonication was reported to be used for exfoliation of layered materials in water (Science-ref. 31), the method has never been explored in non-layered materials, in particular, the effect of ultrasonication on the surface property of materials. In this work, CoFe2O4/C nanoparticles were synthesized and processed using ultrasonic treatment in water. Through the ultrasonic treatment, the electrocatalytic activity of the CoFe2O4/C nanoparticles towards ORR was improved significantly with a higher mass activity (5.05 mA mg−1) than the original CoFe2O4/C (2.75 mA mg−1) in O2-saturated 0.1 M KOH solution. The half-wave potential on the original CoFe2O4/C was also shifted to the positive side by 60 mV. Furthermore, the treated CoFe2O4/C catalyst exhibits a constant half-wave potential with better onset potential after 2000 cycles, and a 50 mV of half-wave potential on the original catalyst was moved to negative under same test condition. The analysis from characterizations reveals that the enhanced ORR performance of the treated CoFe2O4/C resulted from the Co2+ and Fe3+ enriched surface with more cations being occupied in the tetrahedral sites than the octahedral sites after ultrasonic treatment. In addition, compared to the original CoFe2O4/C catalyst, the specific surface area of the treated CoFe2O4/C was improved 1.8 times, mesoporous grown to microspores with 2.2 times increased volumes, which has provided higher active sites and accelerated transport between O2 and electrolyte during the ORR process. The ORR via the 4-electron transfer pathway on the treated CoFe2O4/C catalyst, while the 2-electron transfer process is favoured on the original CoFe2O4/C catalyst. This further signifies that the ultrasonic process had significantly influence on the electrochemical properties of the CoFe2O4/C catalyst.