



Article

# Effects of Silica Shell Encapsulated Nanocrystals on Active $\chi$ -Fe<sub>5</sub>C<sub>2</sub> Phase and Fischer–Tropsch Synthesis

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**Abstract:** Among various iron carbide phases,  $\chi$ -Fe<sub>5</sub>C<sub>2</sub>, a highly active phase in Fischer–Tropsch synthesis, was directly synthesized using a wet-chemical route, which makes a pre-activation step unnecessary. In addition,  $\chi$ -Fe<sub>5</sub>C<sub>2</sub> nanoparticles were encapsulated with mesoporous silica for protection from deactivation. Further structural analysis showed that the protective silica shell had a partially ordered mesoporous structure with a short range. According to the XRD result, the sintering of  $\chi$ -Fe<sub>5</sub>C<sub>2</sub> crystals did not seem to be significant, which was believed to be the beneficial effect of the protective shell providing restrictive geometrical space for nanoparticles. More interestingly, the protective silica shell was also found to be effective in maintaining the phase of  $\chi$ -Fe<sub>5</sub>C<sub>2</sub> against re-oxidation and transformation to other iron carbide phases. Fischer–Tropsch activity of  $\chi$ -Fe<sub>5</sub>C<sub>2</sub> in this study was comparable to or higher than those from previous reports. In addition, CO<sub>2</sub> selectivity was found to be very low after stabilization.

**Keywords:** Fischer–Tropsch; iron carbide; encapsulation; ordered mesoporous silica