Effect of Hierarchically Porous Alumina as Support of Ca-Ni catalyst for Methane Steam Reforming

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Recently, hydrogen is considered as an important future clean energy source in order to solve environmental issues. Steam methane reforming(SMR), which methane react with steam, has been a major process to produce hydrogen[1-2]. SMR process is the highest percentage of hydrogen production market as 48%. Ni catalyst use generally in SMR process because of some benefits like low cost, broad applications, notable conversion and selectivity. The drawbacks of Ni catalyst are carbon coking and sintering at high temperature[3]. In order to suppress the coke formation onto surface of Ni active site, Ca uses as the secondary metal. The catalytic support pore size is a factor of determining catalytic reaction efficiency. Bimodal porous alumina is a new concept support with two different scales pores. The characteristics of mesoporous alumina are high surface area, narrow pore size distribution[4]. The virtues of bimodal porous support are not only increasing catalytic active areas also improving mass and heat transport. Some demerits, nevertheless, need to research like expensive synthesis process and complex steps.

In this study, high ordered macroporous-mesoporous structures alumina support was synthesized by evaporation induced self-assembly procedure method(EISA). The structuring agents for making ordered pores can be removed by calcination as shown Fig. 1. The preparation of high ordered macroporous-mesoporous structures alumina had two steps. First step is a synthesis of polystyrene beads acting as the macroporous templet. As a second step, Mesoporous alumina was synthesized through a sol-gel method with tri block copolymers (Pluronic 123) which acts as the soft templet. After designing of bimodal support, we finally obtained the 5wt.%Ca-15wt.%Ni/Al_2O_3 synthesized via impregnation method. Fig. 2 presents the conversion of methane is similar with result of 5wt.%Ca-15wt.%Ni/mesoporous-Al_2O_3 when bimodal porous alumina support applied to SMR reaction. The highest conversion of CH_4 using hierarchically porous alumina support is almost 100%. Moreover, methane conversion of all catalysts was steadily maintained during 12 hours. This result proves that hierarchically porous alumina support with high surface area improve the catalyst performance in SMR process. It, however, needs to research SMR reaction at low temperature to compare macro-mesoporous alumina and mesoporous alumina.

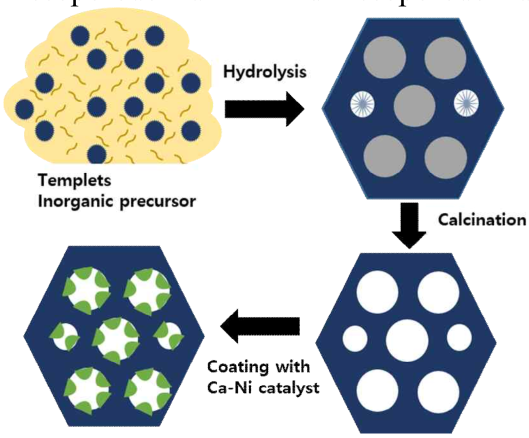

Fig. 1 Mechanism of EISA synthesis[5].

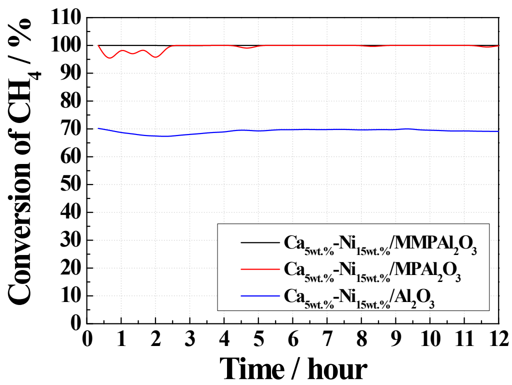

Fig. 2 CH_4 conversion with time on stream in the SMR over Ca-Ni catalysts.

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