Pd supported gamma-Al_2O_3 catalyst : Effect of preparation conditions on the Pd particle size and distribution

Mi Yeon Byun[1,2],
Ji Sun Kim[1]
Dae-Won Park[2],
Man Sig Lee[1,*]
[1] *Ulsan Regional Division, Korea Institute of Industrial Technology, Ulsan 681-310, Korea*
[2]*Department of Polymer Science and Chemical Engineering Pusan National University, Busan 609-305, Korea*

*E-mail: lms5440@kitech.re.kr

Palladium(Pd) supported on Al_2O_3 catalyst have been studied in chemical industry due to high activity in many reaction [1]. In the process of preparation method, characteristics of catalyst is affected by several parameters such as pH value, temperature, solvent, precipitation agent, and metal-support contact times [2-4]. Theses paramater are influenced crystal formation and distribution because stability of the solution causes to rate of nucleation and growth [2,4].

Herein, we investigated the effect of the pH value and temperature on Pd particle size and distribution in Pd/γ-Al_2O_3 catalyst. The two types of γ-Al_2O_3 with different particle size (20 nm, 3 μm) were used the supports. The two different types of support for designated by γ-Al_2O_3 (20 nm) as A and γ-Al_2O_3 (3 μm) as B. The A and B were calcined by 900 ℃ for 4 h in air condition. The Pd/γ-Al_2O_3 catalyst were prepared by deposition-precipitation method with different precipitation pH adjusted to 3.5, 5.5, 7.5, and 11.5 by adding NaOH solution. The temperature of preparation solution were controlled with 40, 60, and 85 ℃. The prepared catalyst note as Pd/*AB* (pH *C*) (*A*: type of support, *B*: solution temperature, *C*: pH value) The catalyst reduction was performed in liquid phase by formalin at 85 ℃. The catalysts were characterized by XRD, N_2-physisorption, FT-IR, CO-Chemisorption, and FE-TEM.

As shown in the Table 1, it can be seem that metal dispersion has different value with pH and temperature, indicating that it is related to nucleation and growth of palladium nanoparticle (NP).. From the results of CO-Chemisorption, it can be seen that Pd/A60 (pH 5.5) catalyst has the highest Pd dispersion of 43.16%. Also, we confirmed that solution temperature affected to Pd particle size and distribution. According to the temperature of solution was controlled from 40 ℃ to 60 ℃, Pd dispersion was increased. However, more than solution temperature of 60 ℃, Pd dispersion lead to decreased. It should be emphasized pH and temperature play an important role in Pd dispersion and particle size.

Above these results, we can be concluded that dispersion and particle size of Pd were influenced on the preparation condition. Particularly, temperature and pH value assocaited with rate of nuclear growth of Pd nano particle and interaction of support – metal precursor, representing that is strongly affected Pd dispersion.

Table1. CO-Chemisorption results of Pd/γ -Al_2O_3 catalysts

Catalysts	Temperature	Cumulative Quantity (mmol/g)	Metallic surface area (m^2/g)	Metal dispersion (%)
Pd/A60 (pH 3.5)	60℃	0.0996	188.94	42.41
Pd/A60 (pH 5.5)	60℃	0.1041	192.27	43.16
Pd/A60 (pH 7.5)	60℃	0.0701	132.84	29.82
Pd/A60 (pH 11.5)	60℃	0.0308	58.41	13.11
Pd/B60 (pH 5.5)	60℃	0.0177	33.73	7.57
Pd/A40 (pH 5.5)	40℃	0.0490	93.84	21.06
Pd/A85 (pH 5.5)	85℃	0.0461	87.42	19.62

REFERENCES

[1] Ji Sun Kim, Jeong-Wook Park, Seong-soo Hong, Man Sig Lee, Sci. Adv. Mater., 8 (2016) 1955
[2] Dong Jin Suh, Tae-Jin Park, Ind. Eng. Chem. Res., 31 (1992) 1849
[3] Kee Young Koo, Un Ho Jung, Wang Lai Yoon, Int. J. Hydrogen energy, 39 (2014) 5696
[4] Katia R. Souza, Adriana F.F. de Lima, Fernanda F. de Sousa, Lucia Gorenstin Appel, Appl. Catal. A Gen., 340 (2008) 133