Heterogeneous Catalyst for NO_x Formation in a Microwave Plasma

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ABSTRACT

Application of catalysts to enhance chemical reactions toward more products is an undisputable part of nowadays processes wherein most of them rely on heterogeneous catalysts. One of the most crucial processes, which is integrated with human life feedstock, is the Haber-Bosch (H.B) process. In the H.B process, heterogeneous catalysts perform an important role to intensify process efficiency and production yield [1]. However, increasing demand for food reservoirs along with global concern about greenhouse gas emission bring serious challenges to undergo H.B process. Hence, attempts are arising to replace it with cleaner/greener methods. Among them, plasma-based method received special attention due to many advantages, mainly it can be launched directly from the electricity with high energy efficiency, it is fast responding and adaptable for small-scale usage [2]. In addition, it was confirmed that plasma-based processes can be boosted via an appropriate catalyst. In literature, numerous studies of catalyst-assisted plasma for ammonia production can be found, in contrast, fewer studies were dedicated to NO_x formation whereas in many aspects both products are noteworthy [3]. In this work, molybdenum-based heterogeneous catalysts supported on γ-alumina have been prepared. After characterizing, they were used in a pulsed microwave plasma in the post-plasma zone with N_2/O_2 mixes to study the NO_x formation. The FTIR spectroscopic study of the activity of the catalysts reveals that there is an enhancement of NO_x production mostly due to the synthesis of NO_2 whereas NO is the only species detected without catalyst. Even if there is no remarkable difference between the performances of catalysts, a detailed study of the catalysts' physicochemical properties links modifications of structural properties to performance changes. Particularly, different calcination temperatures of the alumina support result in phase change along with an impact on NO_x production and selectivity. Further, the effect of different loadings of MoO_3 was discussed. At low loading, there is a positive effect in terms of NO_2 production, however, at higher loadings, it shows a negative effect. Briefly, our results indicate that the major influence of catalysts on NO_x production can be assigned to the catalyst support, rather than MoO_3. Nevertheless, considering the position of catalysts in our experiment and the lifetime of the reactive species generated by the plasma, one of our challenges is to move toward the discharge zone to enhance plasma-catalyst interactions.

References

[1] B. S. Patil, Q. Wang, V. Hessel, and J. Lang., Catal. Today (2015), 256, 49–66.
[2] A. Bogaerts et al 2020 J. Phys. D: Appl. Phys. 53 443001.
[3] P. Peng et al., ChemSusChem (2019), 12, 16, 3702–3712.