# Alkane Reactions over Nanoporous Catalysts

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## INTRODUCTION

Some limitations of zeolites with regard to their small pore diameters has prompted research into meso-porous silica, such as SBA-15 which has highly ordered, uniform structure [1] and is found useful in applications such as catalytic oxidation [2], dehydrogenation [3] and alkylation [4] reactions. Investigations into hydroisomerisation reactions with SBA-15 are in early development and therefore will be the investigation of this research.

## AIM

The aim of this work is to characterise three SBA-15 samples (1 wt% Pt-SBA, 1 wt% Ni-SBA and 0.5 wt% Pt / 0.5 wt% Ni -SBA), test for hydroisomerisation reactions with n-C7 and compare with Pt-USY-712.

## METHODS

All the SBA-15 samples (Pt-SBA, Ni-SBA and Pt/Ni-SBA) were synthesised at MMU. The catalysts were metal-loaded by the method of incipient wetness impregnation with $Pt(NH_3)_4Cl_2.H_2O$ and $Ni(NO_3)_2.6H_2O$ in 0.1 M HCl solvent to load the catalyst with a total of 1 wt% Pt and Ni for the mono-metallic and 0.5 wt% Pt and 0.5 wt % Ni for the bi-metallic catalyst. Characterisation techniques used include XRD. Nitrogen adsorption porosimetry, Pore volume, SEM, EDAX, TEM and TGA.

## RESULTS & DISCUSSION

The catalysts were characterised using XRD, nitrogen adsorption porosimetry, Pore volume, As shown in Figure 1, 2, 3, and 4 respectively. Typical SEM images of SBA-15 and USY-712 can be seen in Figure 5 and Figure 6. The surface morphology of the two catalysts was determined to be similar; however it is clear the USY-712 catalyst particles are much smaller than the SBA-15 particles. TEM images Figure 7 and Figure 8 show that Pt-SBA-15 was found to have a pore size 6 times larger than Pt-USY-712 at 6.532 ± 1.809 nm and a metal cluster size 8 times larger with even less dispersion, decreasing the metal sites available for reaction. This was believed to result from the presence of Al+3 ions on the zeolite and the more exact method of ion exchange utilised for loading USY-712 over incipient wetness impregnation used on SBA-15. Figure 9 displays the selectivity to isomerisation and cracked products for Pt-USY-712. Figure 10 shows the total conversion at different temperatures.

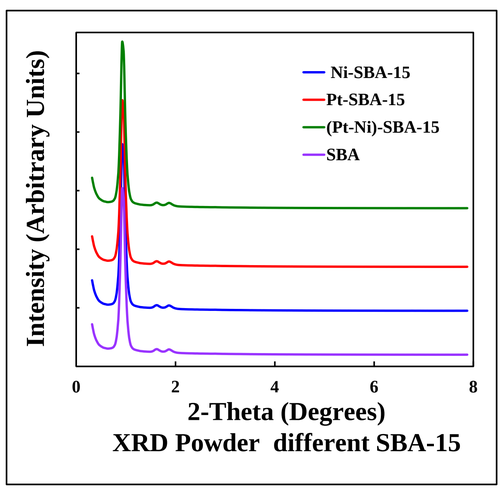


Figure 1: XRD pattern of SBA-15

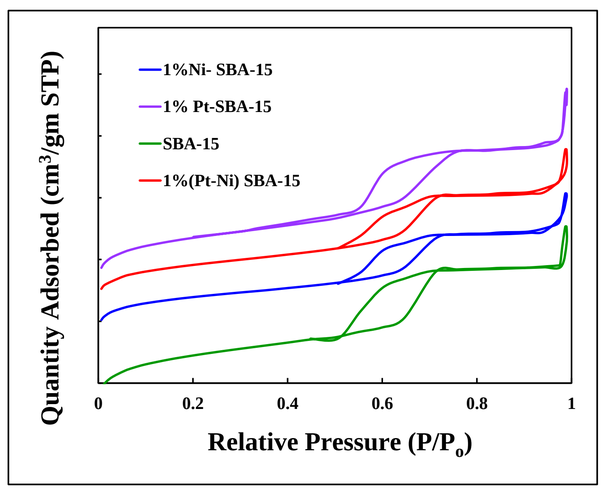


Figure 2: Nitrogen adsorption of SBA-15

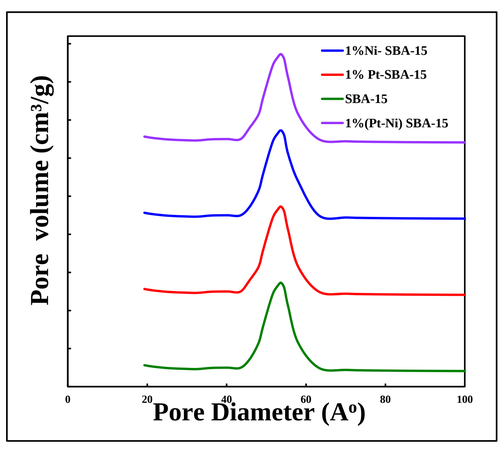


Figure 3: BJH pore size of SBA-15

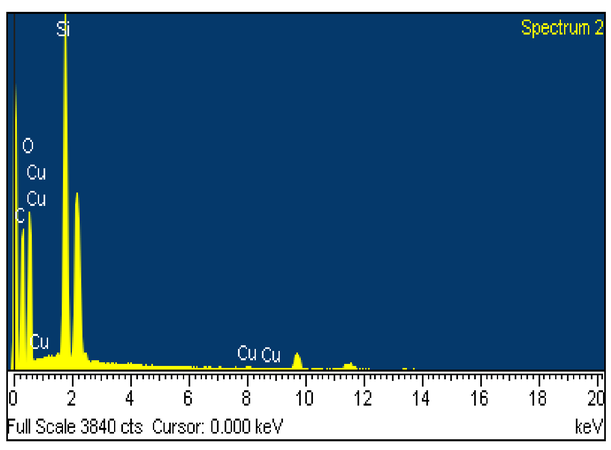


Figure 4: EDAX of SBA-15

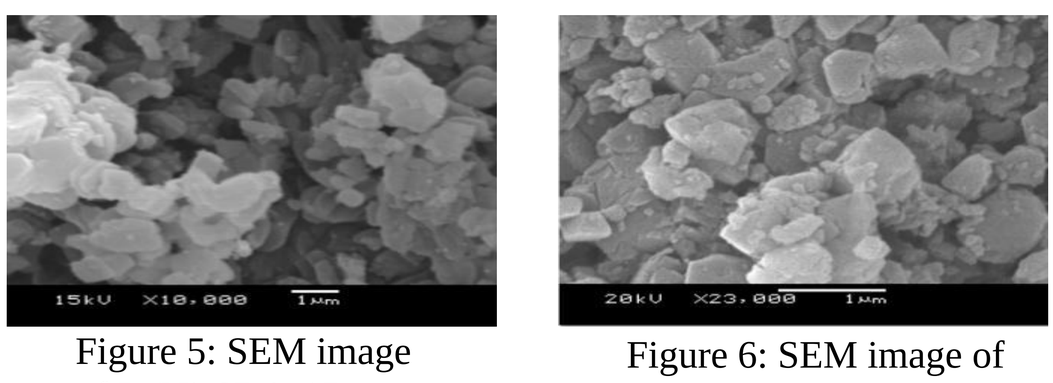

Figure 5: SEM image of Pt/Ni-SBA-15.



Figure 6: SEM image of Pt-USY-712.

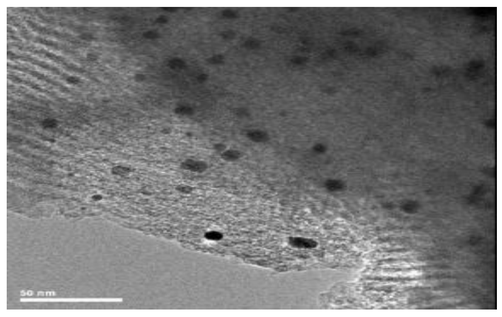

Figure 7: HR-TEM image of Pt-SBA-15 at 50 nm.

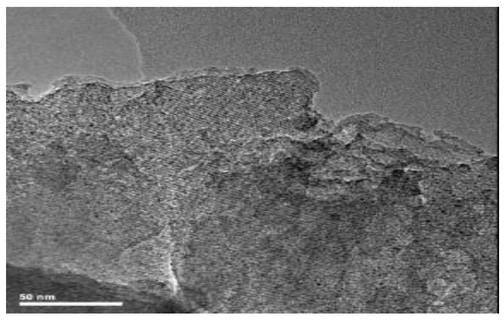

Figure 8: HR- TEM image of Pt-USY-712 at 50 nm.

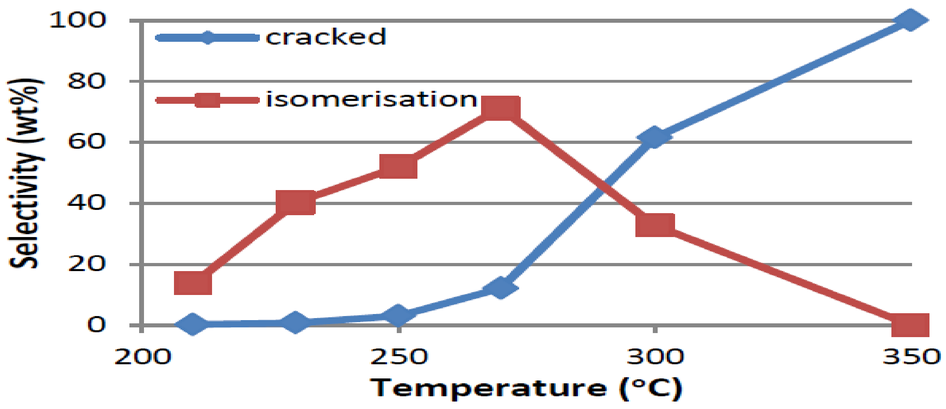


Figure 9: Isomerization/cracking selectivity of Pt-USY-712.

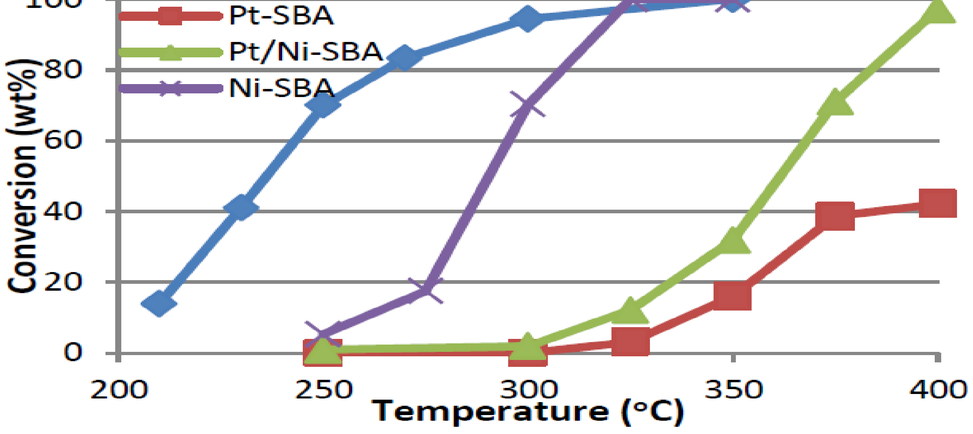


Figure 10: % conversion n-heptane over different catalysts

## CONCLUSIONS

The presence of Ni on the bi-metallic Pt/Ni-SBA-15 helped in the distribution and size of the Pt on the catalyst. This increased the surface area of metal available for reaction and resulted in an increased activity on the bi-metallic catalyst when compared to the mono-metallic Pt-SBA-15.

## REFERENCES

[1] Jiao, L., Regalbuto, J. R. (2008). Journal of Catalysis., 260, 342–350.

[2] He, C., Li, P., Cheng, J., Li, J., Hao, Z. (2010). Environmental Process & Sustainable Energy, **29**, 4, 435-442.

[3] Dinse, A., Khennache, S., Frank, B., Hess, C., Herbert, R. (2009). Journal of Molecular Catalysis, 307, 45-50.

[4] Chiu, J. (2004). Journal of Catalysis, 221, 400-412.

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