Plasma Modified Nickel Catalysts for Biomass Conversion

David T. Lundie[1], *J.A. Rees*

[1]**Hiden Analytical Ltd, 420 Europa Boulevard, Warrington, WA5 7UN, UK. dlundie@hiden.co.uk**

INTRODUCTION

Organic waste through biomass conversion can be used for energy production and the synthesis of a variety of chemicals. One of the synthesis routes is via biogas to syngas catalytic conversion, by CO_2 reforming of CH_4. For the methane reforming reaction, all metals of the VIIIA group on a large variety of supports have been studied. Ni shows good catalytic activity, especially when well dispersed on the support. Plasma modification of Ni samples has been shown to increase the dispersion of these catalysts [1].

Plasma modification of a Ni /Al_2O_3/CeO sample was performed in a microreactor based on the Hiden CATLAB. The reactor was constructed to allow a catalyst to be heated under controllable temperature and gas flow conditions. A schematic is shown in Figure 1. In addition to the standard furnace arrangement a dielectric barrier discharge (DBD) could also be generated over the length of the catalyst. The DBD consisted of an inner coaxial tungsten wire electrode of 1.0 mm diameter and an outer cylindrical metallic electrode wrapped around a quartz tube and connected to ground. The tungsten electrode is connected to the open-circuit end of the secondary winding of a high voltage transformer operated at 50 kHz.

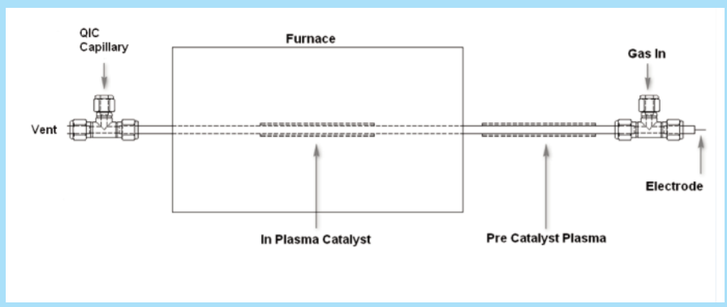

Figure 1: **Plasma reactor**

The catalyst was loaded into the reactor and flushed with He for 1.5 hrs while the plasma was running. The sample was then transferred to a standard CATLAB reactor for characterisation using TPR and reaction testing.

RESULTS AND DISCUSSION

Figures 2 and 3 show the results of a TPR experiment on both the unmodified and plasma modified Ni Samples. The two TPR are similar however the plasma modified sample appears to have a broader main reduction peak. Further work is required to determine any further differences.

Figures 4 and 5 show the TPRx results of unmodified and plasma modified Ni samples. In the unmodified sample, conversion of $CH_4 + CO_2 \rightarrow 2H_2 + 2CO$ occurs at around 650˚C with complete conversion of the CO2 occurring at around 700˚C. In the modified Ni sample, conversion of $CH_4 + CO_2 \rightarrow 2H_2 + 2CO$ occurs at around 600˚C.

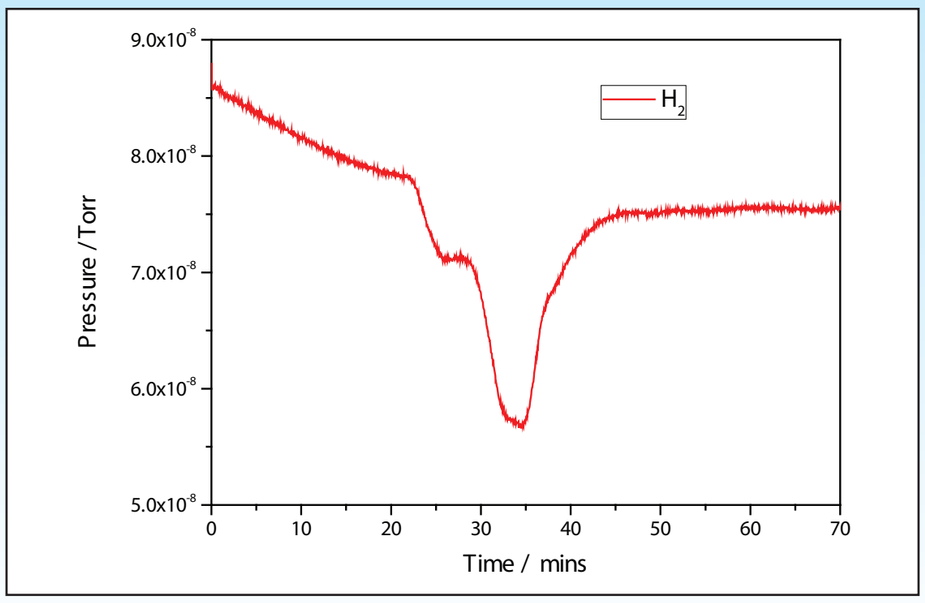

Figure 2: **Ni/Al_2O_3/CeO TPR**

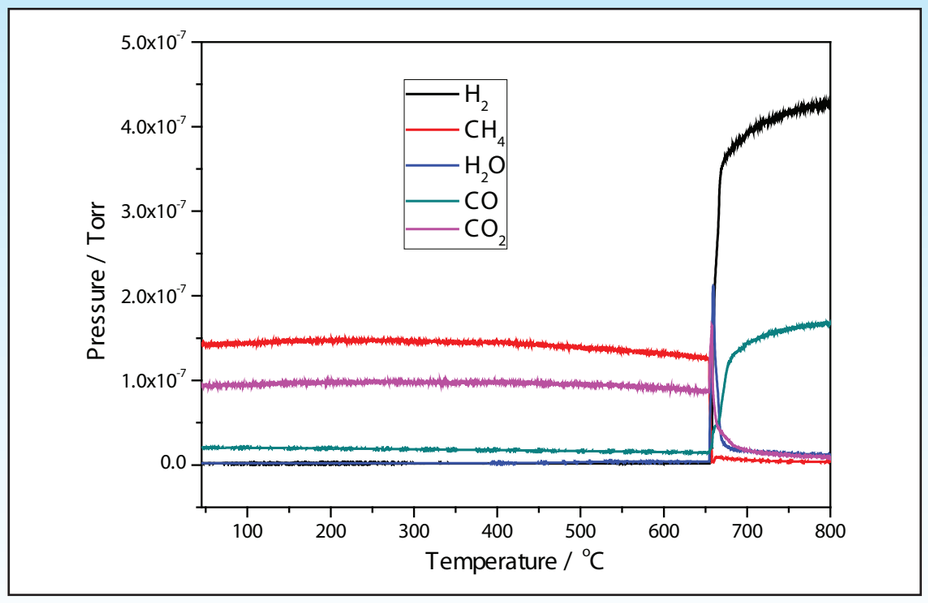

Figure 3: **Ni/Al_2O_3/CeO TPRx**

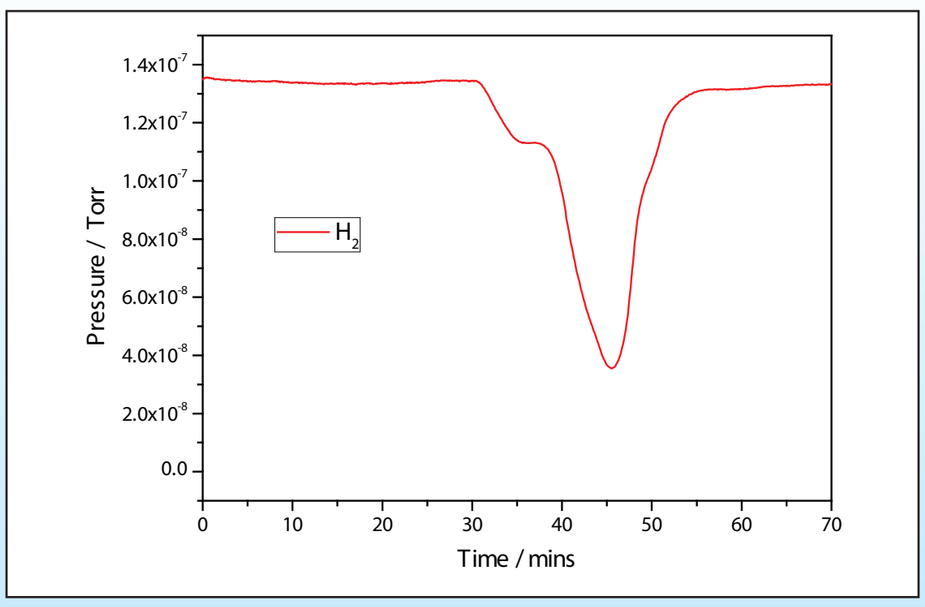

Figure 4 **Plasma Modified Ni/Al_2O_3/CeO TPR**

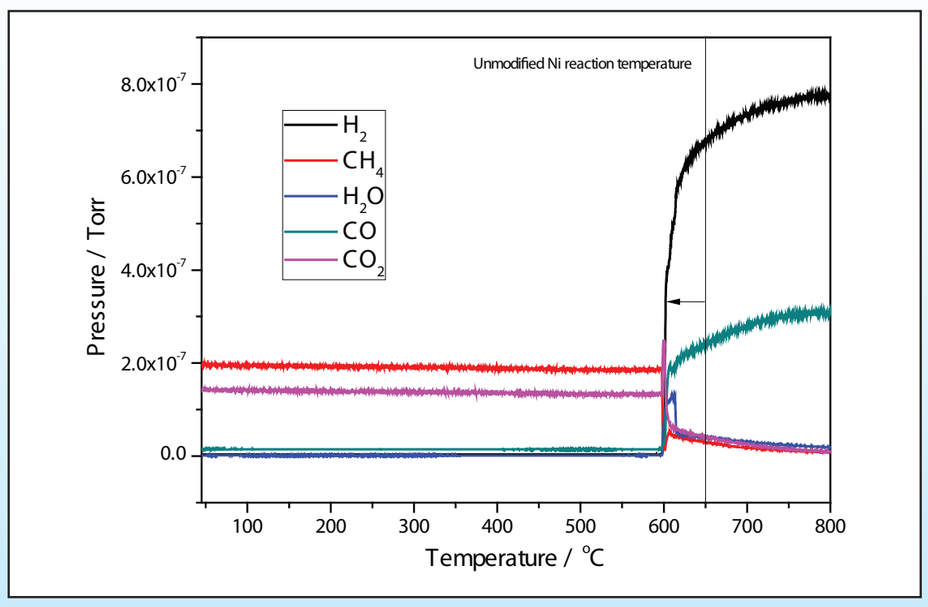

Figure 5: **Plasma Modified Ni/Al_2O_3/CeO TPRx**

Conclusions:

- **Methane activation occurred in both Ni Samples.**
- **TPReaction demonstrate the high activity and selectivity of these catalysts.**
- **Plasma modification shows potential for preferentially altering the reactive properties of the catalyst**

References:

[1] Y. Zhu, Z, Li, Y, Zhou, H. Wang, Journal of Natural Gas Chemistry 14 (2005) 1-3.

For Gas Analysis, Plasma Characterisation, Catalysis and Surface Science

Tel: +44 (0)1925 445 225 Fax:+44 (0)1925 416 518 E-Mail: info@hiden.co.uk www.HidenAnalytical.com

TP 08/0210