Topic number: 1

# PACKED BED COAXIAL DBD DISCHARGE IN $CH_4$-$N_2$ MIXTURES - MIMIC OF TITAN'S LOWER ATMOSPHERE

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An FTIR study of the gaseous products formed in a coaxial packed bed DBD discharge filled with glass pellets and fed by three different atmospheric pressure mixtures of $N_2$:$CH_4$ (98:2, 95:5, 90:10) operated in flowing regime has been carried out at two different voltages (20 and 25 kV) and at ambient temperature. FTIR analysis of the gaseous products showed that HCN, $C_2H_2$, $NH_3$ and $C_2H_6$ are the main products of our $CH_4/N_2$ DBD plasma (Fig 1).

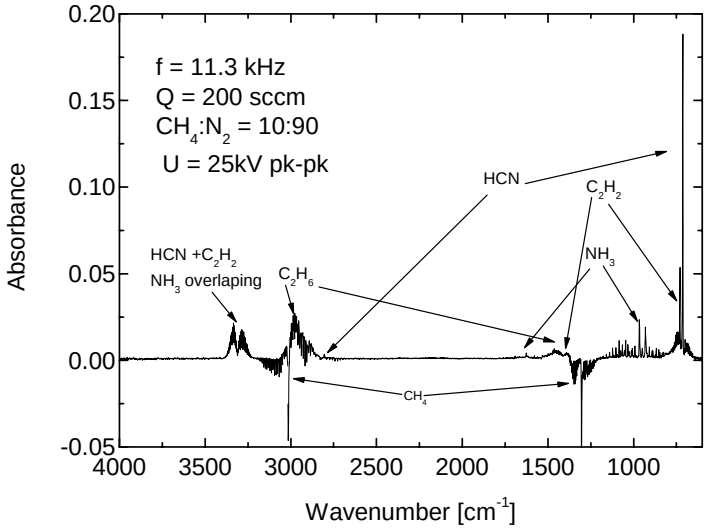


**Figure 1.** A typical FTIR spectrum recorded in a gas cell filled with products formed in the DBD discharge operating at atmospheric pressure and total gas flow 200 sccm, driven by a constant AC voltage U=25 kV pk-pk fed by a $CH_4$-$N_2$ gas mixture with a 10:90 ratio. Note the negative absorbance indicates loss of $CH_4$ during the operation of the discharge.

The yields of these compounds are such that HCN > $C_2H_2$ > $C_2H_6$ > $NH_3$. The dependence of the product concentration of HCN and $NH_3$ on the specific input energy $\mu$ for three different initial $CH_4$ concentrations is shown in Fig 2.The gas flow rate and specific input energy have a significant effect on the product synthesis. The packed bed DBD discharge was found to be a promising method for HCN synthesis and $NH_3$ production from an energy consumption point of view. Such experiments can provide information that aids our understanding of processes in Titan's atmosphere. Within the discharge we observed the formation of the same compounds as

observed in Titan's atmosphere (HCN, $C_2H_2$, $C_2H_6$, $NH_3$) by the Huygens Surface Package and by Cassini Observer [1]. In particular the observation of ammonia in the DBD but not in our earlier corona discharge suggests, $NH_3$ is formed by heterogeneous chemistry at the dielectric surface in assistance of excited and ionic particles. Furthermore discharges can provide relevant information on the formation of the anions [2] and have therefore allowed of the anions observed by Cassini to be identified.

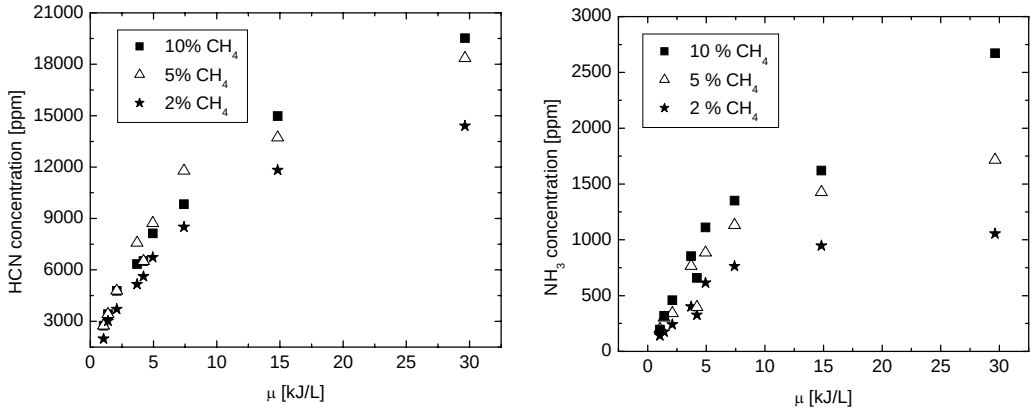


**Figure 2.** The dependence of the product concentration of HCN and $NH_3$ on the specific input energy for three different initial $CH_4$ concentrations in nitrogen (2, 5 and10%).

However, we note that different discharges have different sources of ions/excited molecules and thus in discharges as a simulation mimic it is necessary to carefully define the plasma conditions and their relevance to specific regions of Titan's atmosphere. For lower pressures the glow discharge is specific while the higher pressure regions are related to corona and DBD discharges.

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**Reference**

[1] V. Vuitton, P. Lavvas, R.V. Yelle, M. Galand, A. Wellbrock, G.R. Lewis, A.J. Coates and J.-E. Wahlund, 2009 *Planet. Space Sci.* doi:10.1016/j.pss.2009.07.014.
[2] G. Horvath, Y. Aranda-Gonzalvo, N. J. Mason, M. Zahoran, S. Matejcik, 2010 Eur. Phys. J. Appl. Phys. **49**, 13105.