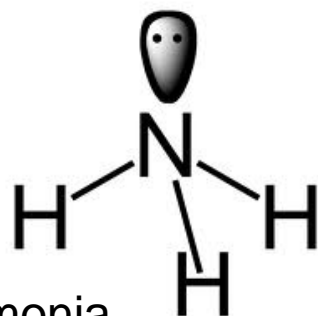
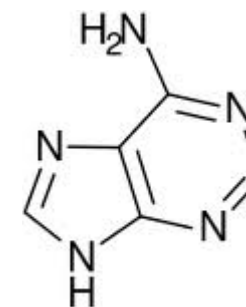
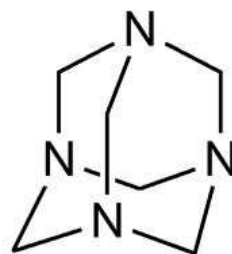


Amines and optical properties of Titan's aerosols

N. Carrasco, A. Mahjoub, T. Gautier,
P.R. Dahoo, C. Szopa, G. Cernogora



HMT



Adenine

Which Nitrogen form in Titan aerosols ?

- Aerosols layer in the high atmosphere
- The ACP analysis confirmed a high N-content in the nuclei
- But no further data on the chemical environment of nitrogen in the aerosols

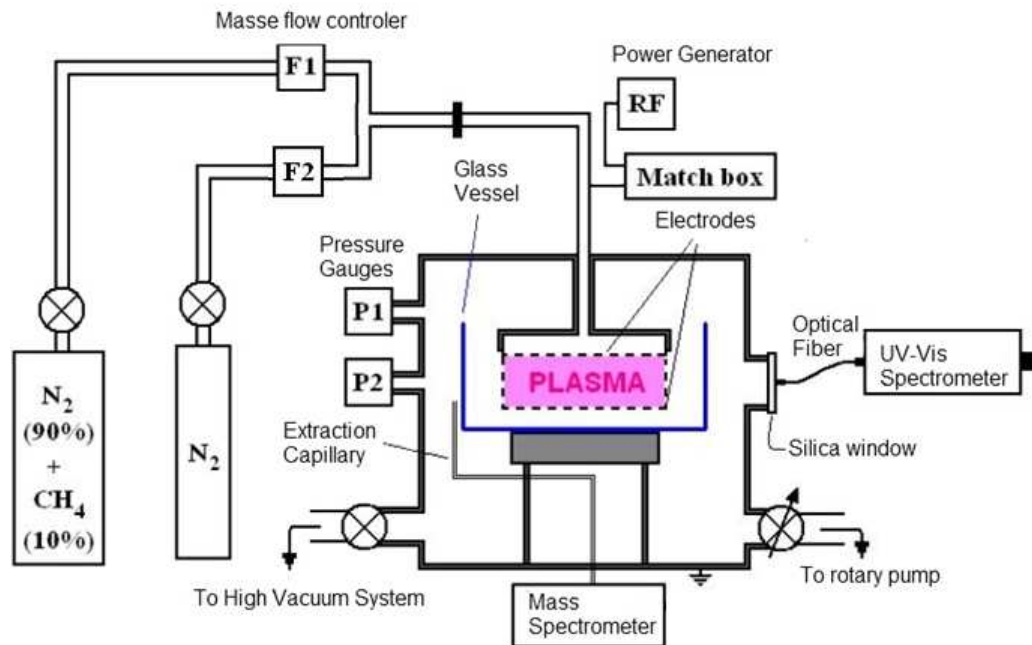


Credits: NASA/JPL/Space Science Institute

→ What is its main chemical form ?

→ How does it affect the aerosols optical properties ?

Synthesis of aerosols analogues



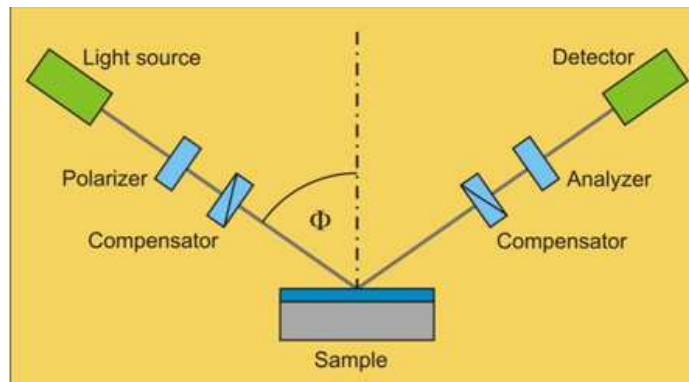
PAMPRE experimental Set-up

- 2 hours
- $P = 0.9$ mbar
- Power = 30W
- $T =$ room-Temp
- Gas mixture: $N_2:CH_4$
 $0\% < CH_4 < 10\%$

Tholin thin film on
Silicon substrates:
thickness $< 1 \mu\text{m}$

Optical indices in UV-Vis: ellipsometry

ex-situ characterisation: Spectroscopic ellipsometry



$$\rho = \frac{r_p}{r_s} = \tan(\psi)e^{i\Delta}$$

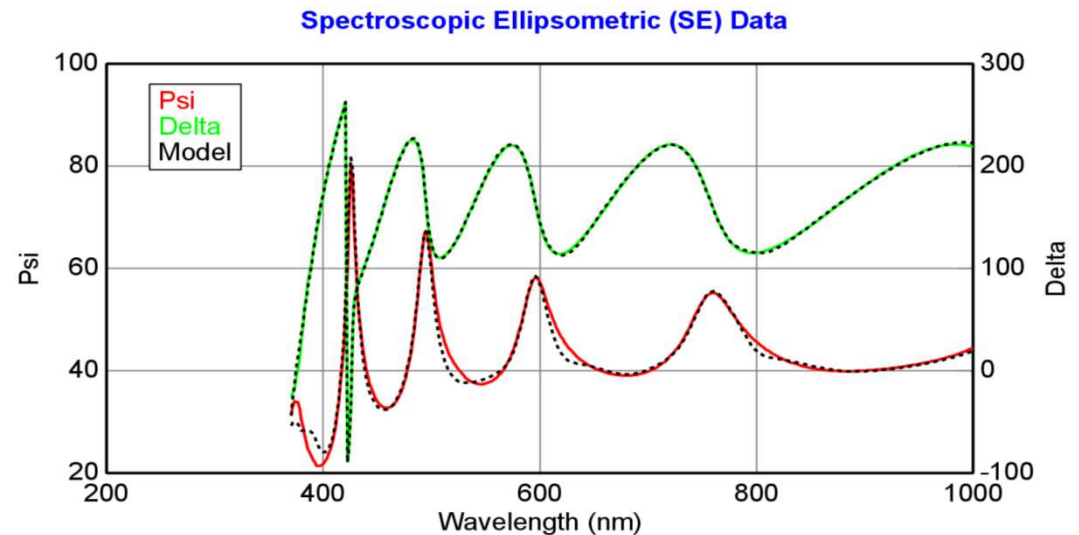
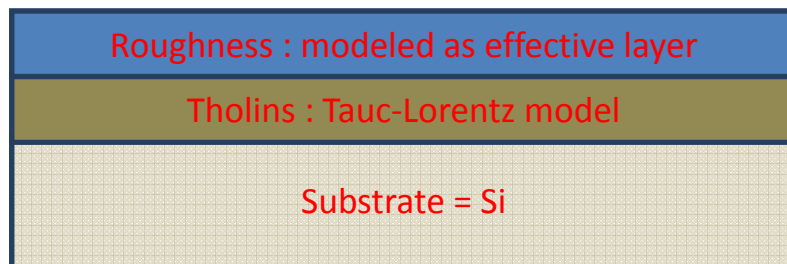
complex reflectance ratio

Linearly polarized light incident at an oblique angle onto the sample. The reflected light from the sample surface is, in general, elliptically polarized.

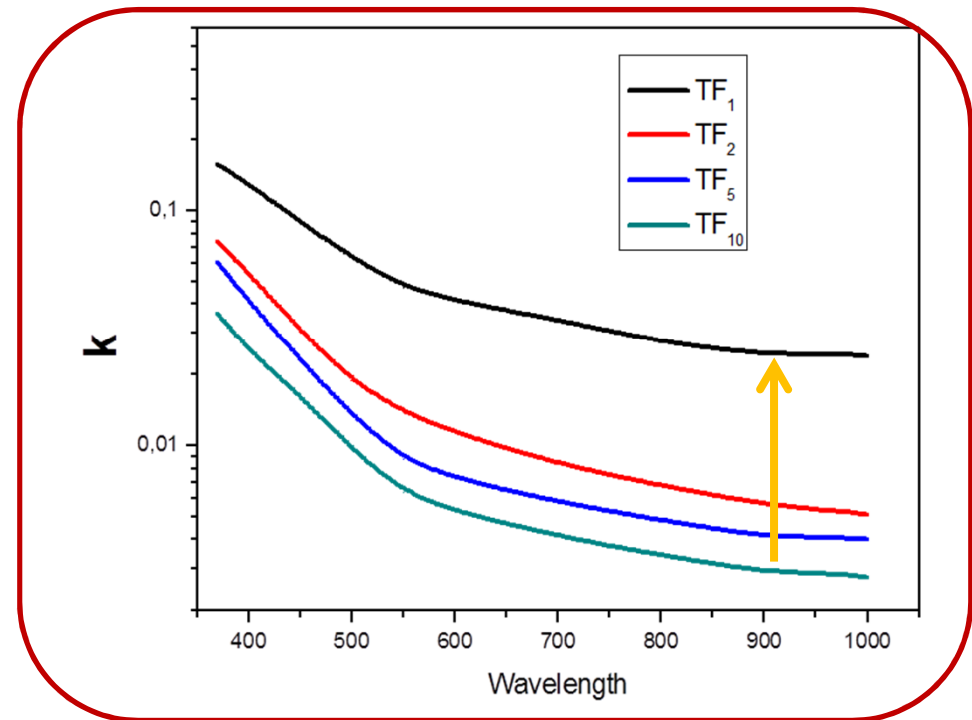
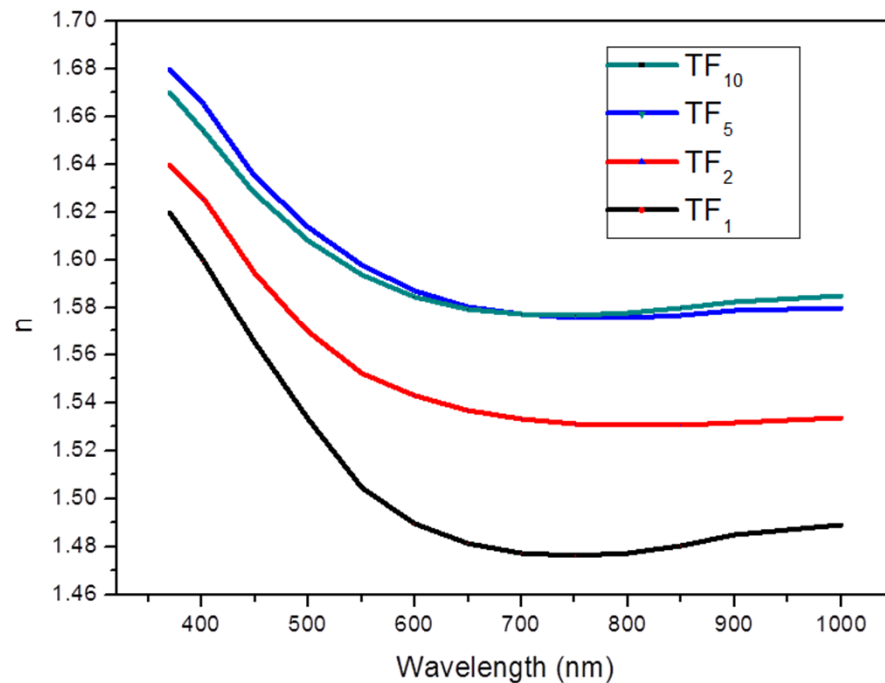
r_p : parallel polarized light r_s : perpendicular polarized light

Optical indices in UV-Vis: ellipsometry

Modeling: Measured ψ and Δ are compared with ψ and Δ calculated by a multilayer model (CompleteEASE© software) as function of $n(\lambda)$ and $k(\lambda)$



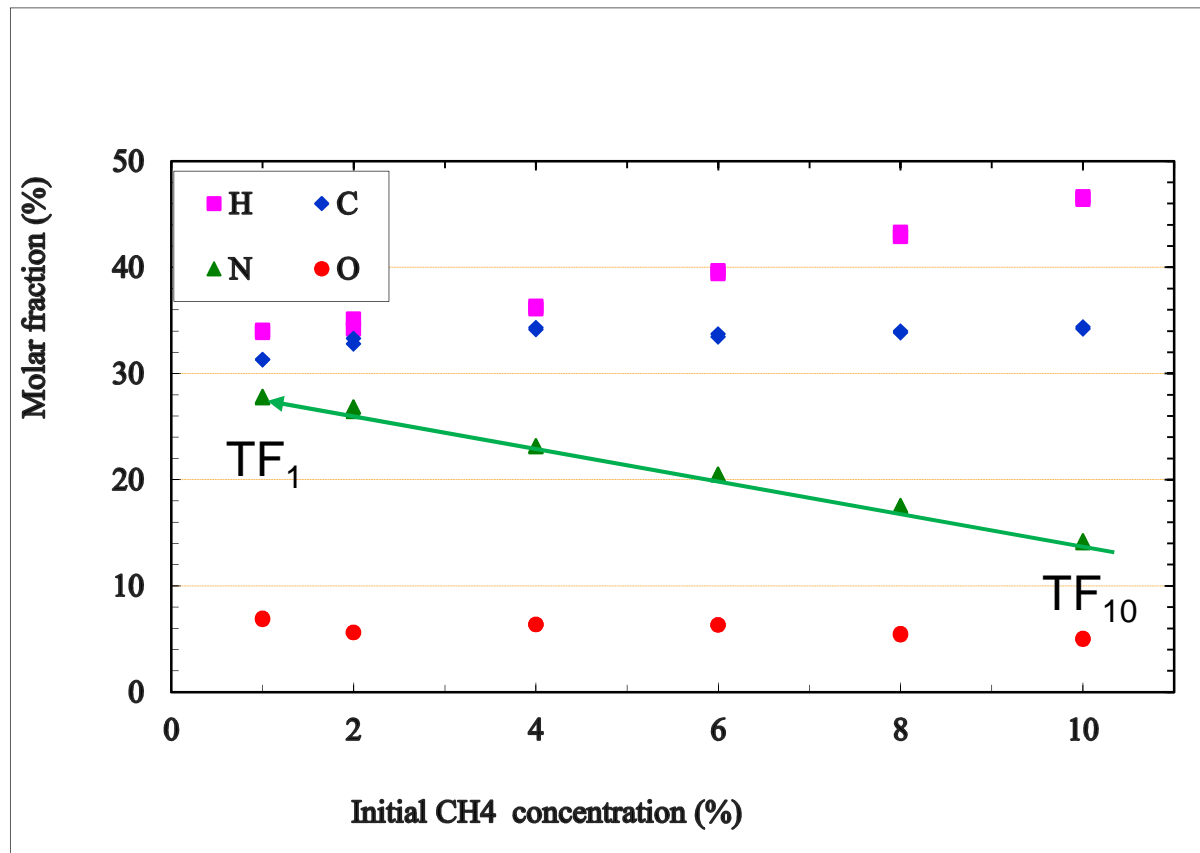
Optical indices in UV-Vis: ellipsometry



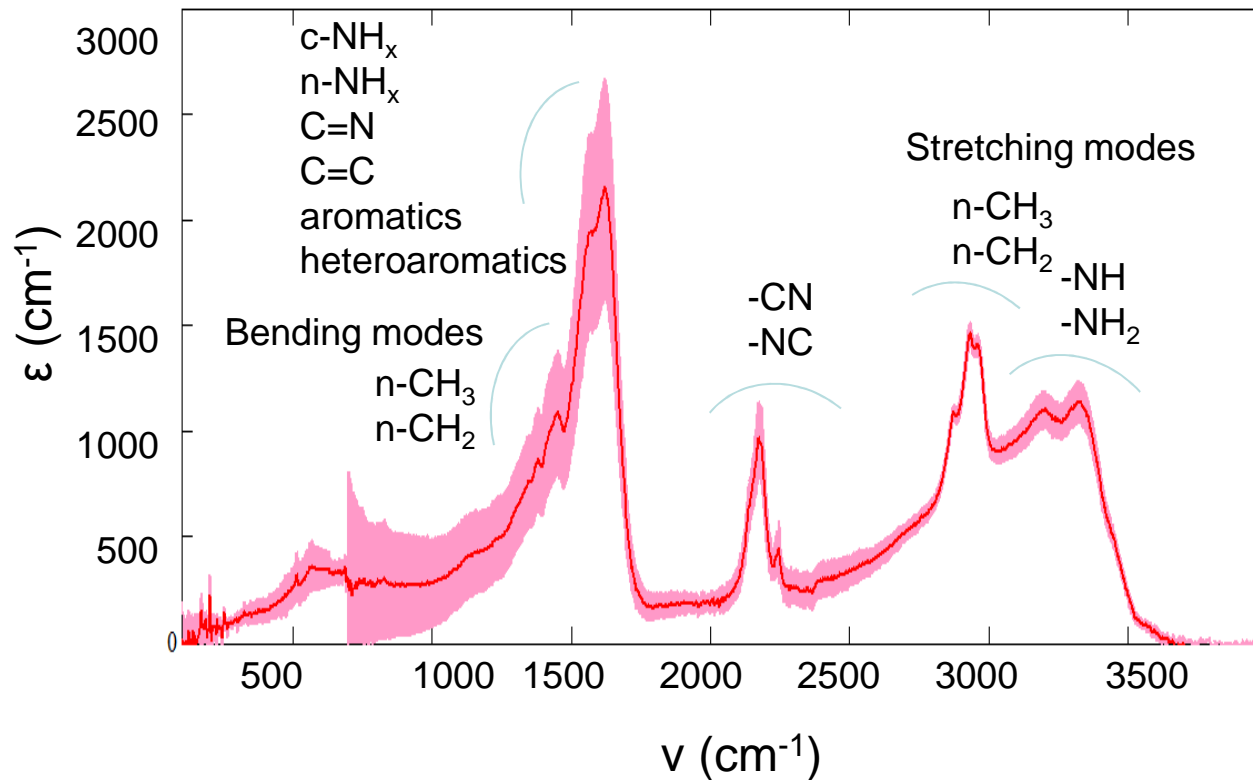
- Tholins UV-Vis absorption decreases with $[CH_4]_0$
- Which function responsible for UV absorption ?

N-bearing function

- Elemental analysis: N-content increases in TF_1



Infra-red absorption analysis

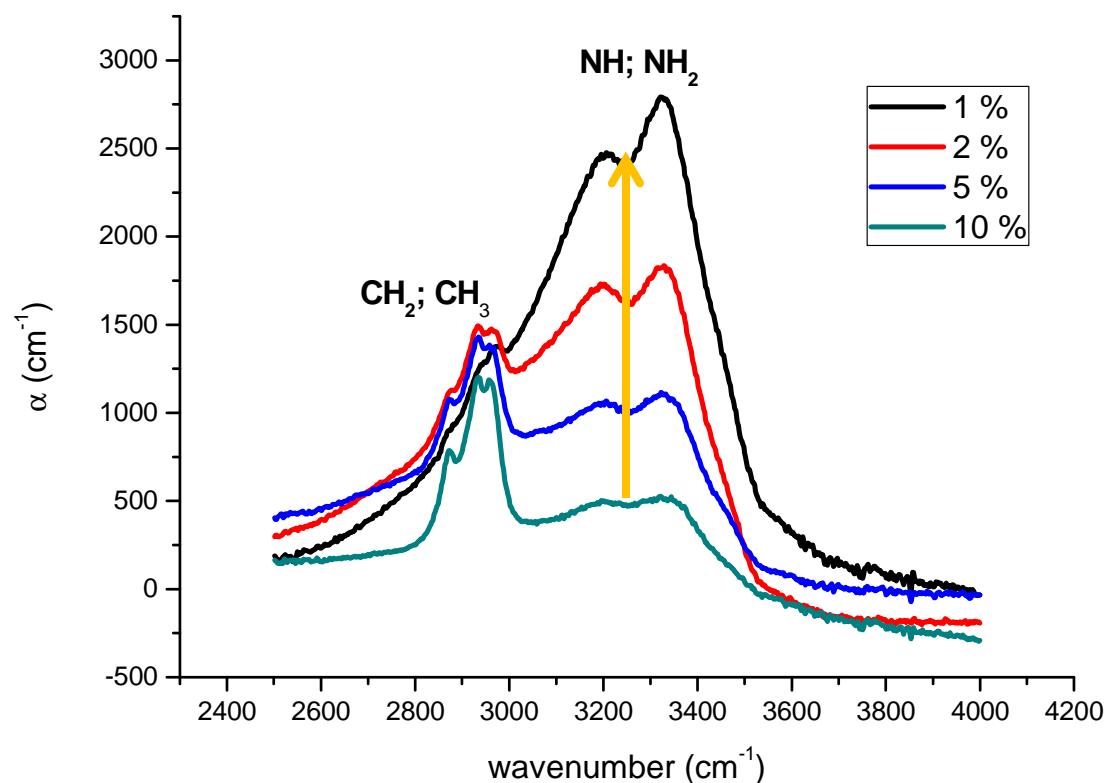


$$I_t = I_0 \times e^{-2\alpha \times d}$$

- d measured by ellipsometry
- no offset
- no calibration factor

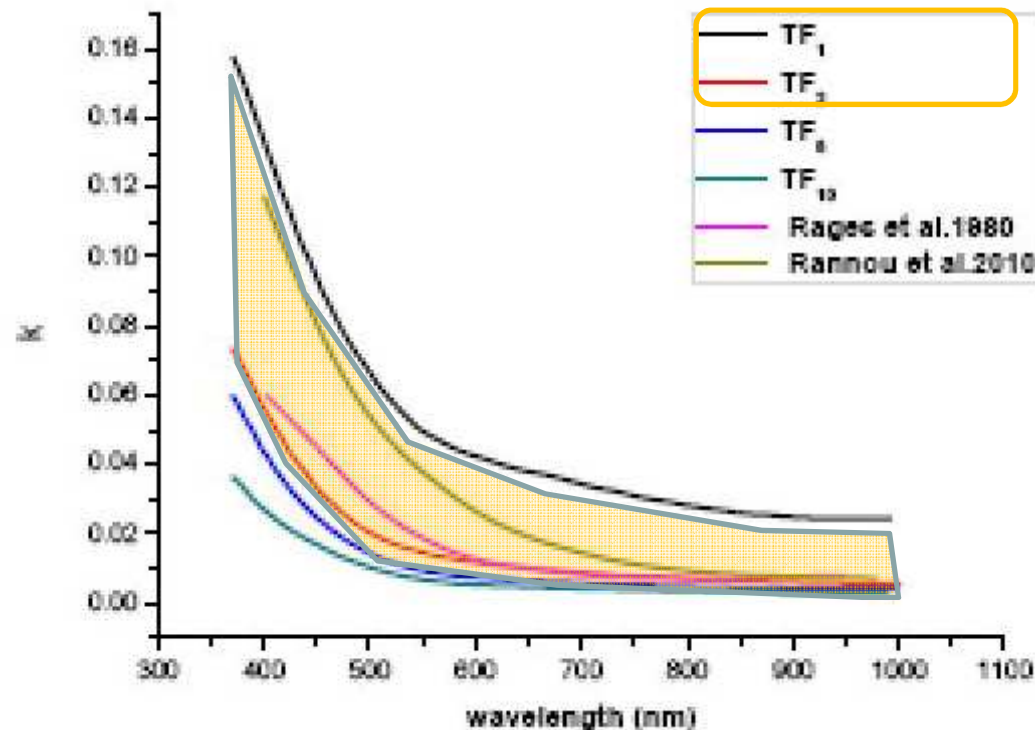
=> Allows spectra comparison

Infra-red absorption analysis



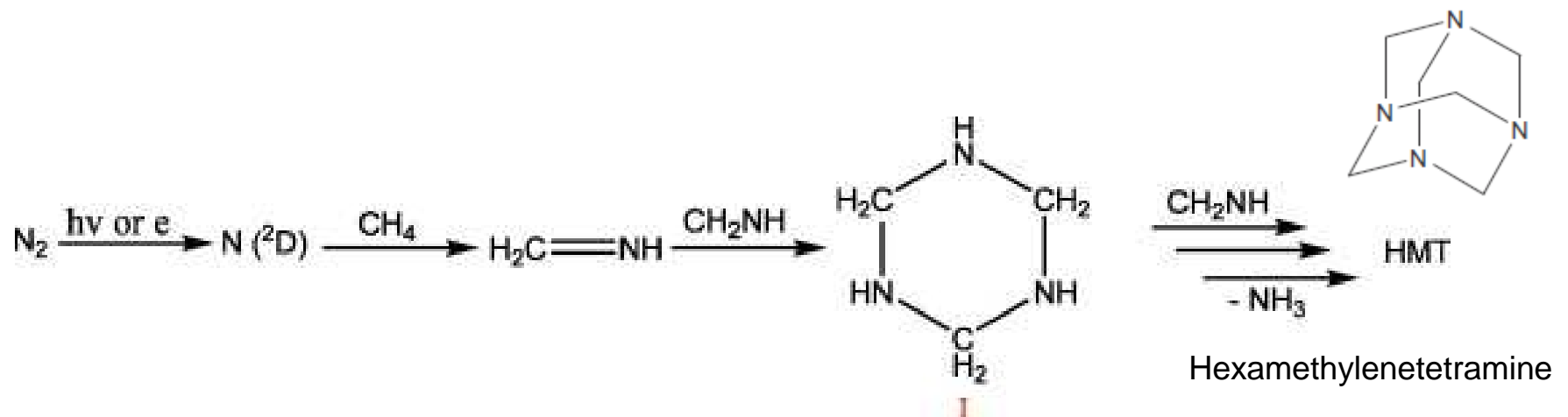
Amine-rich tholins at lower CH₄ percentage

Comparison with Voyager and Cassini/VIMS observations.



- The NH amine $n \rightarrow \sigma^*$ transition leads to an increase of k
- In agreement with amine-rich aerosols in Titan

HMT in Titan aerosols



- NMR analysis by He et al. 2012, Icarus
- HMT as major compound in Titan aerosol analogues
- Also detected in cometary ice analogues Vinogradoff et al. 2011, A&A

Conclusion

- Titan aerosol analogues rich in amines –NH
- Responsible for an important UV absorption
- In agreement with the k optical indice deduced from VIMS observations

Confirmation:

Amine signature at $\sim 3000 \text{ cm}^{-1}$ not (yet) detected in the VIMS absorption data