Consiglio Nazionale delle Ricerche

Istituto per l'Energetica e le Interfasi – sez. Milano

Oxides synthesis in a hybrid burner

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OUTLINES

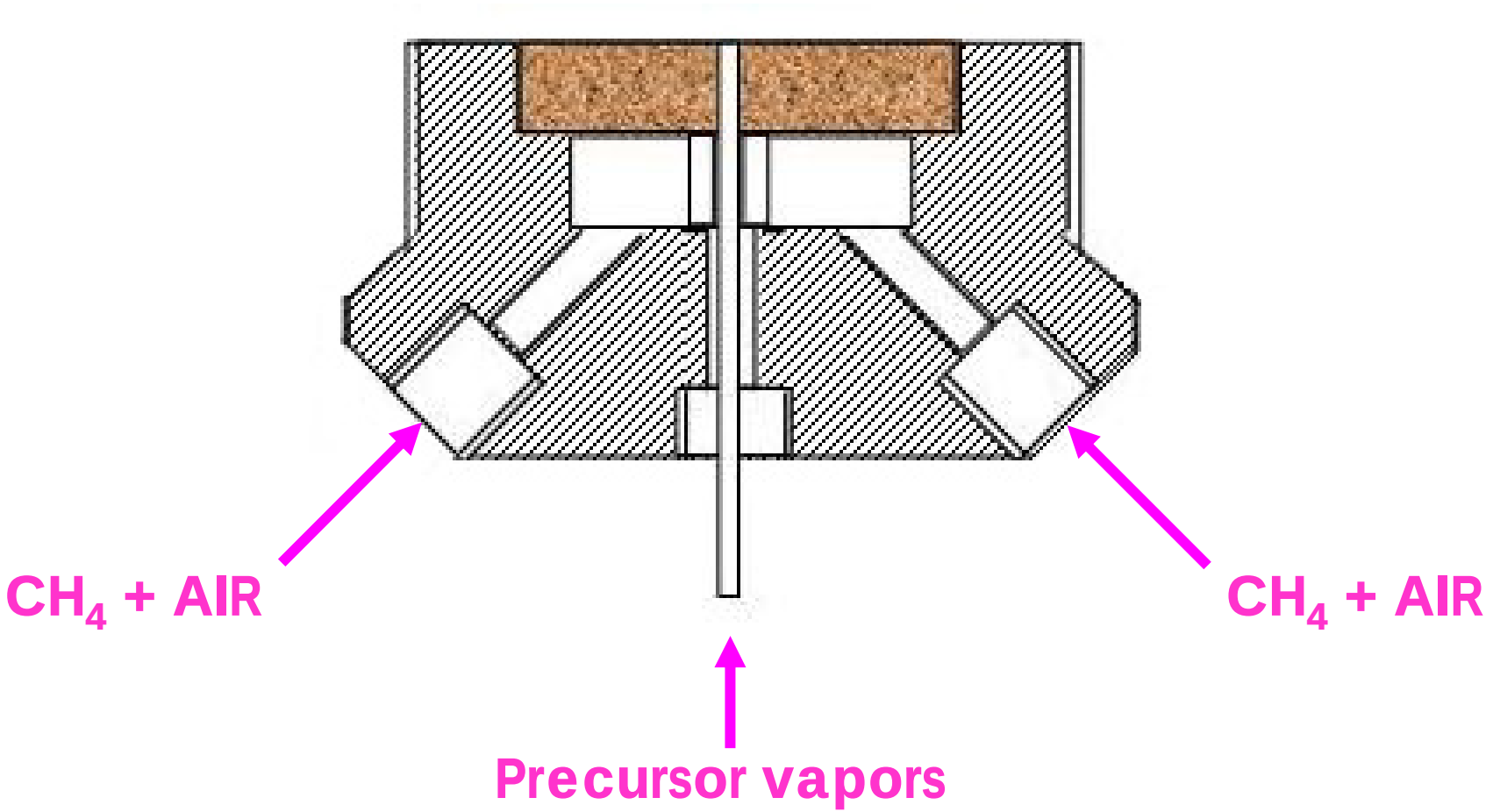
1. Why nanoparticle synthesis at CNR-Milan?
2. The Hybrid burner
3. Precursor injection system and sampling setup
4. Flame structure
5. Ex situ characterization of powder
6. On line diagnostics: (LLS) and LII
7. My work at PTL

Why nanoparticle synthesis at CNR-Milan?

- Starting in 2005 as most obvious extension from Combustion and soot studies
- The field was nearly unexploited in Italy
- FIRB (an Italian Fainancial Support)

BURNER DETAILS

Hybrid burner



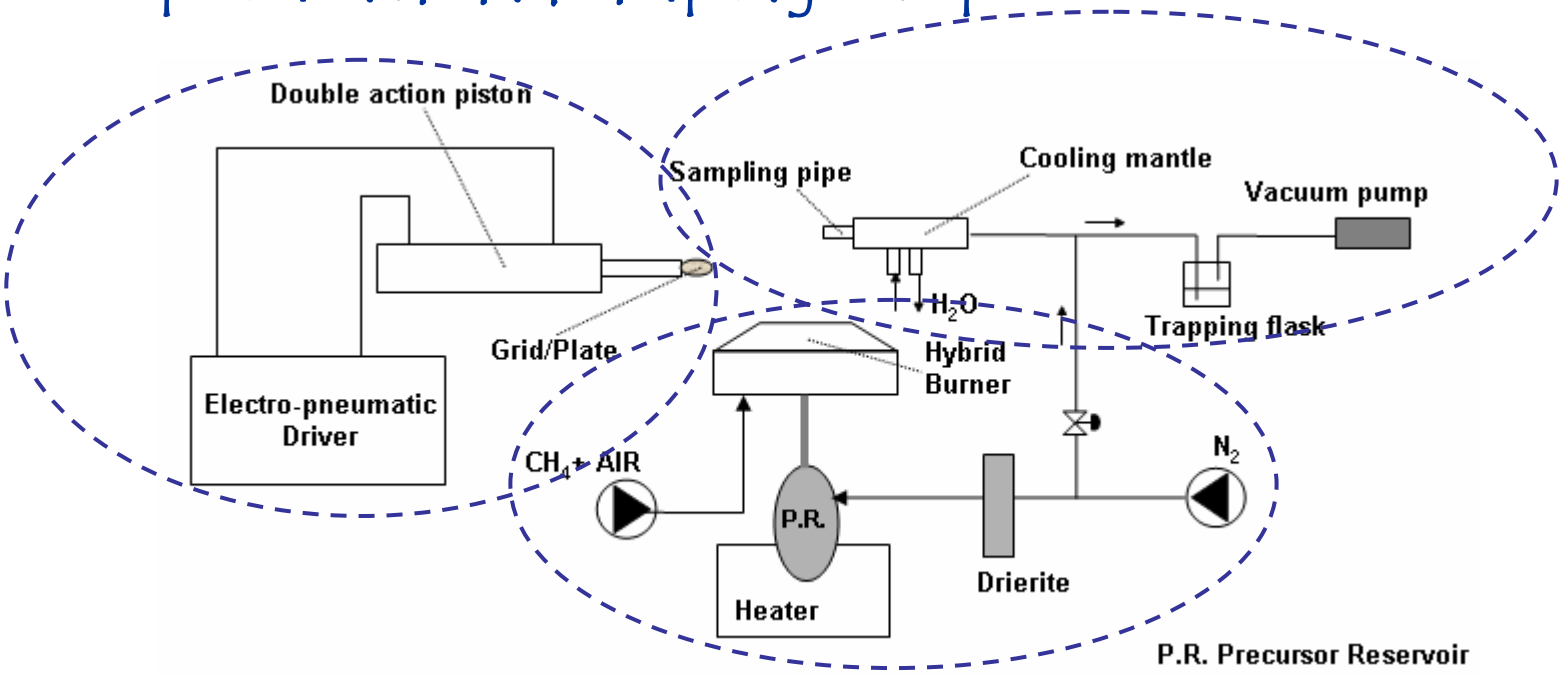
M.S. Wooldridge et al., NanoStructured Materials 11 (1999) 955

BURNER DETAILS

- HB ADVANTAGES
  - Safe (no flashback)
  - Easy to implement
  - Smooth gradients in the axial direction
  - Easy to warm up (at least the precursor tubing)
  - Precursor pipe easily replaceable in case of clogging
- HB DISADVANTAGES
  - Not suitable for mass production
  - Strong horizontal gradients in the first flame stretch

FLAME SYNTHESIS

Experimental and sampling set up.

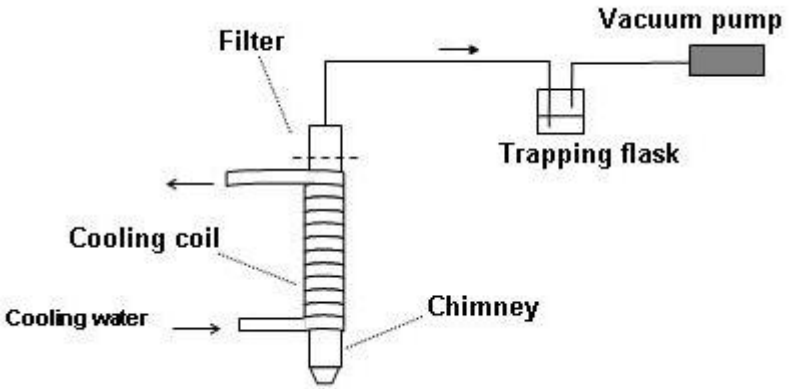


V_{CH4} = 0.684 Nl/min;
V_{AIR} = 8 Nl/min
Φ = 0.81

- Titanium tetraisopropoxide - $Ti(OC_3H_7)_4$
- Vanadium oxytriethoxide - $O=V(OC_2H_5)_3$
- Tetraethyl-orthosilicate - $Si(OC_2H_5)_4$

FLAME SYNTHESIS

Collection of "frozen" powders



in the line of the technique described in K. Wegner, W.J. Stark, S.E. Pratsinis, Mater. Lett., 55 (2002) 318

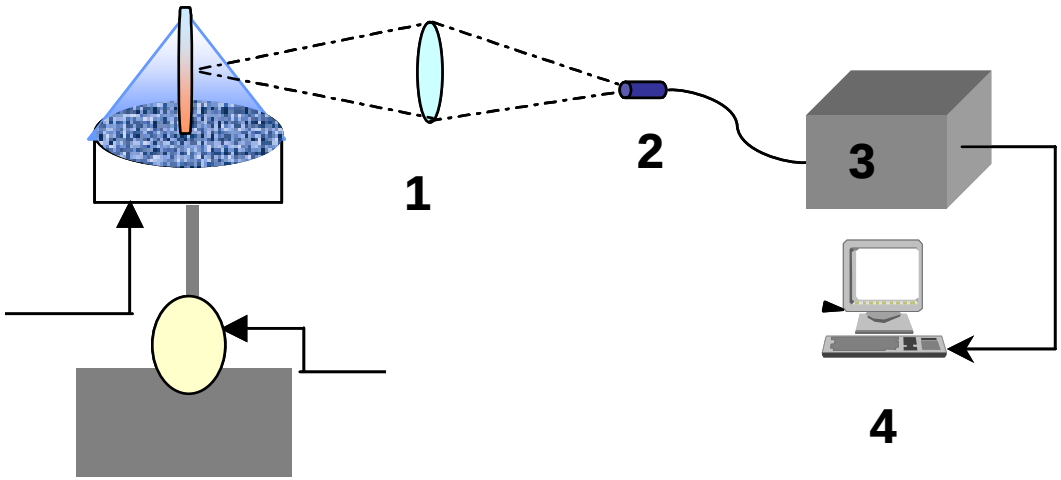
FLAME CHARACTERIZATION

The mainly used techniques were :

- Spontaneous Light Emission Spectroscopy
- Flame Imaging

FLAME STRUCTURE

EMISSION SPECTROSCOPY APPARATUS



1. Lens
2. Optical fiber
3. Spectrograph + diode array + Controller
4. PC

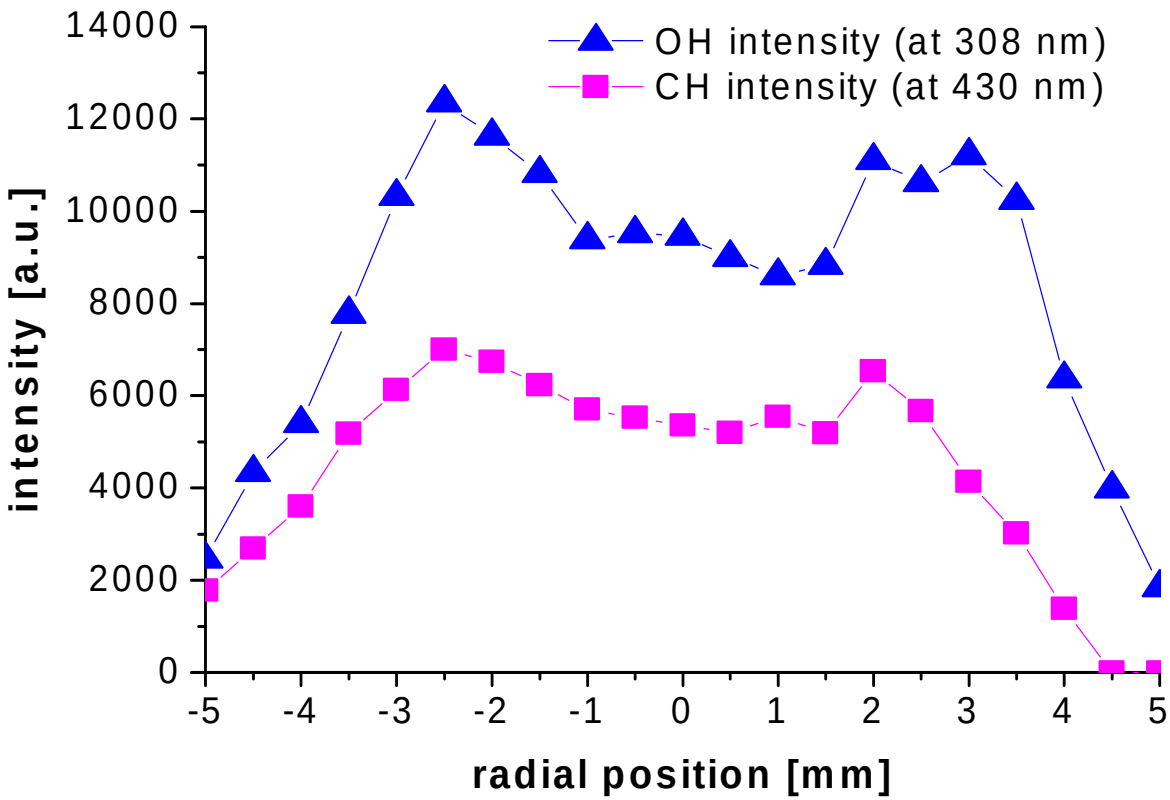
FLAME STRUCTURE

- THE ROLE OF THE SUSTAINING FLAME IN THE PRECURSOR REACTION

Only heating or contribution with chemical species?

FLAME STRUCTURE

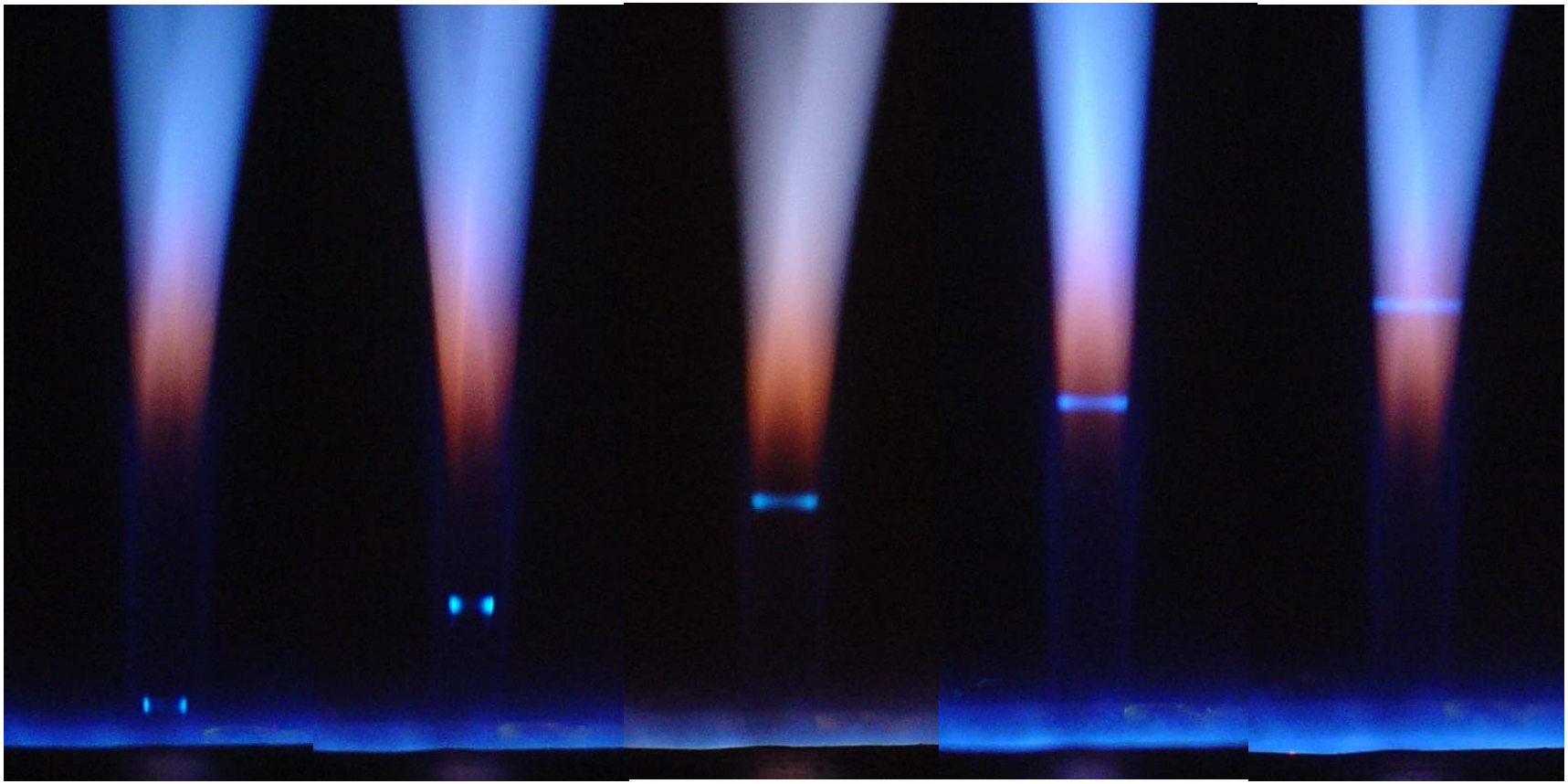
External combustion LAYERS



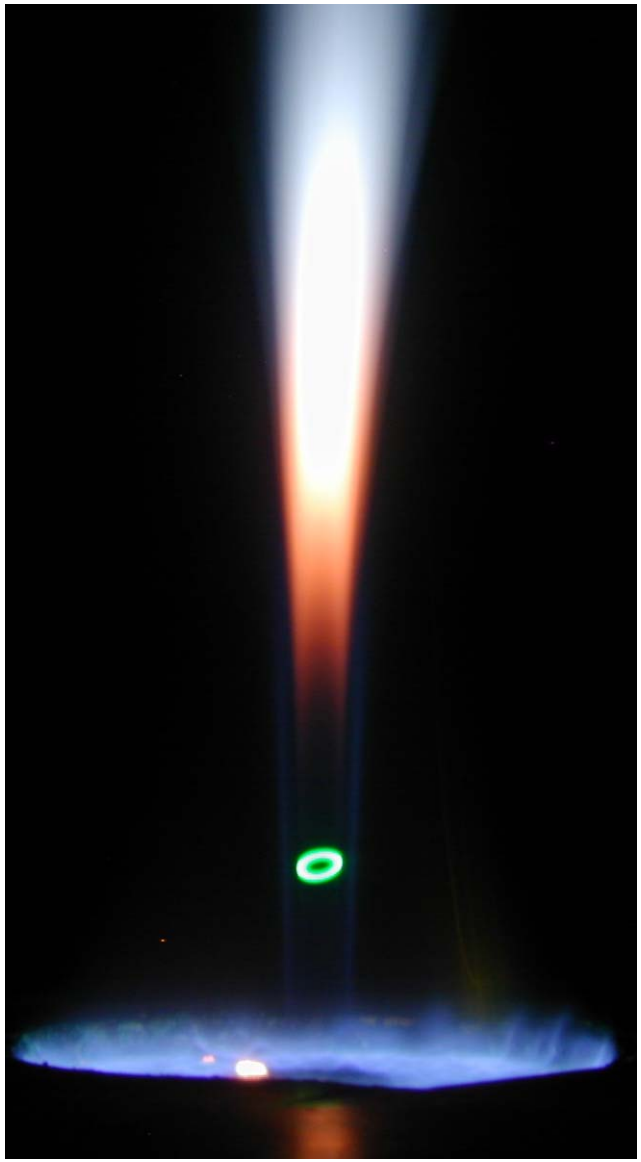
30 mm HAB

CH & OH HORIZONTAL PROFILES

LIGHT EMISSION SPECTRA



FLAME STRUCTURE

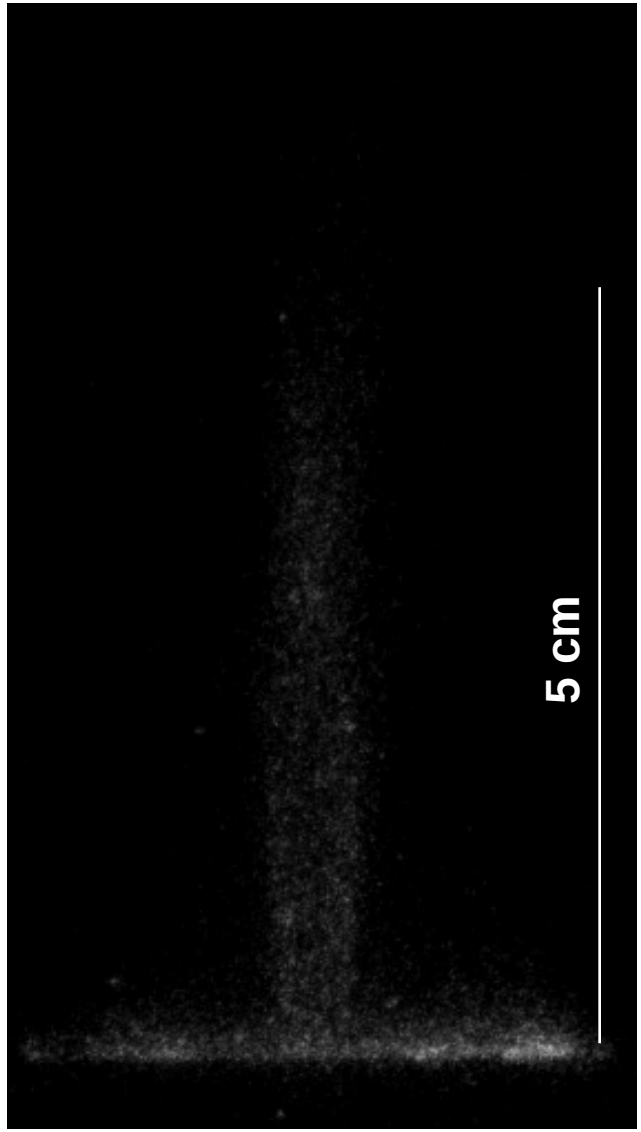


FLAME STRUCTURE

CCD image of the OH emission from the reaction flame

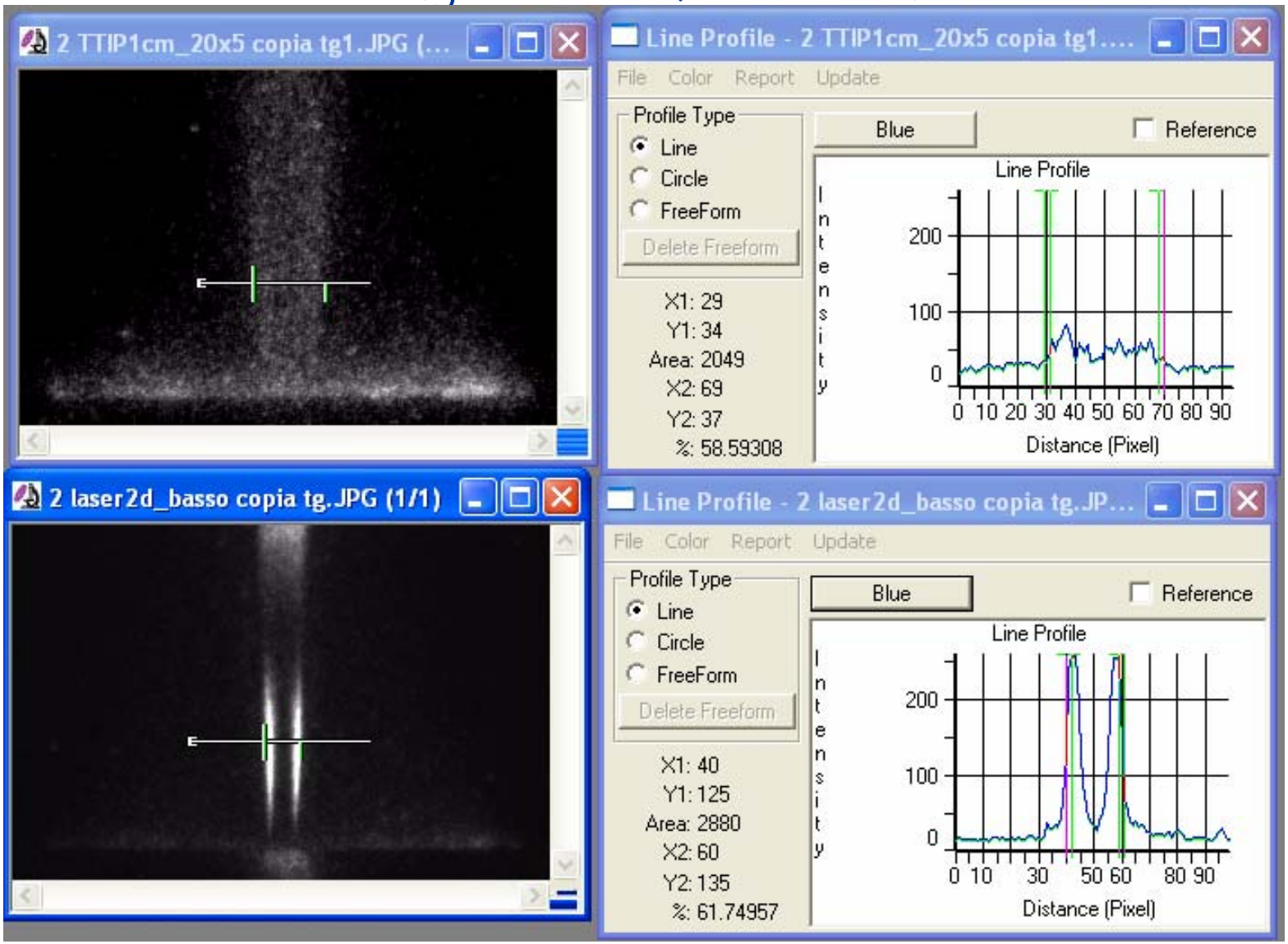
How to obtain this image?

In front of the objective a narrow band interferntial filter (310 nm) was placed to detect OH radicals

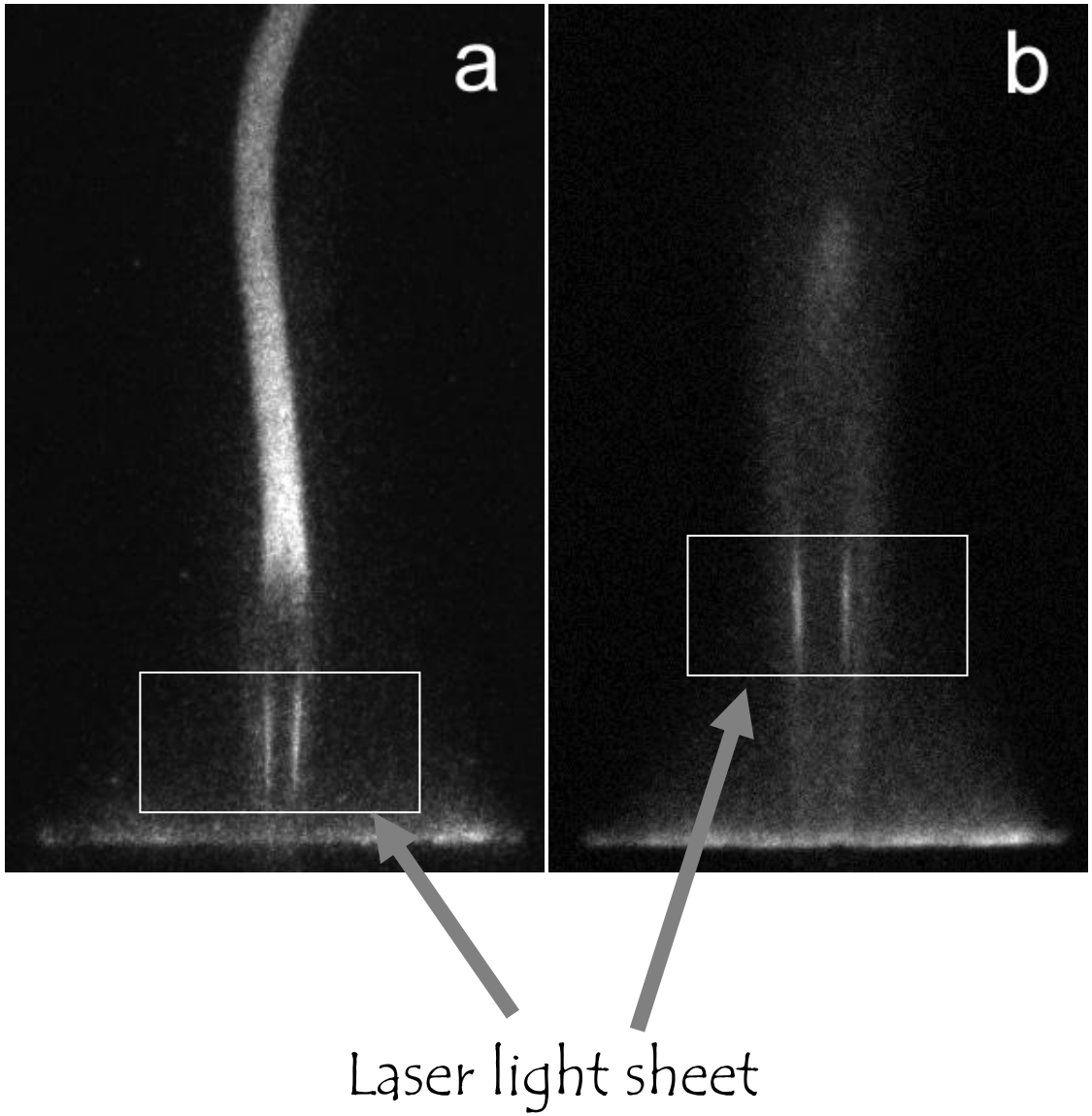


FLAME STRUCTURE

CCD images of the diffusion flame



Superimposed CCD images of the OH emission and of the scattered light from Ar+ cw laser sheet in the TiO2 (a) and in the SiO2 (b) flames.



1.the supporting flame shows no OH at the excited state few mm above the burner

2.The OH emission picture then shows only the OH radicals from the reaction flame

3.The scattering layer (particles layer) is internal to that zone.