Release – Adhesion enhancement of polymeric substrates using Atmospheric Plasma Technology

i-SUP 2008

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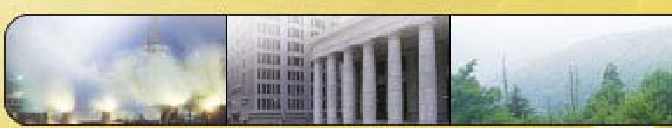

Outline

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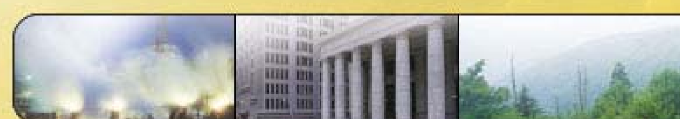
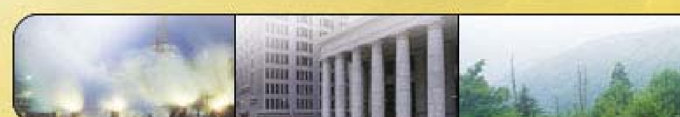
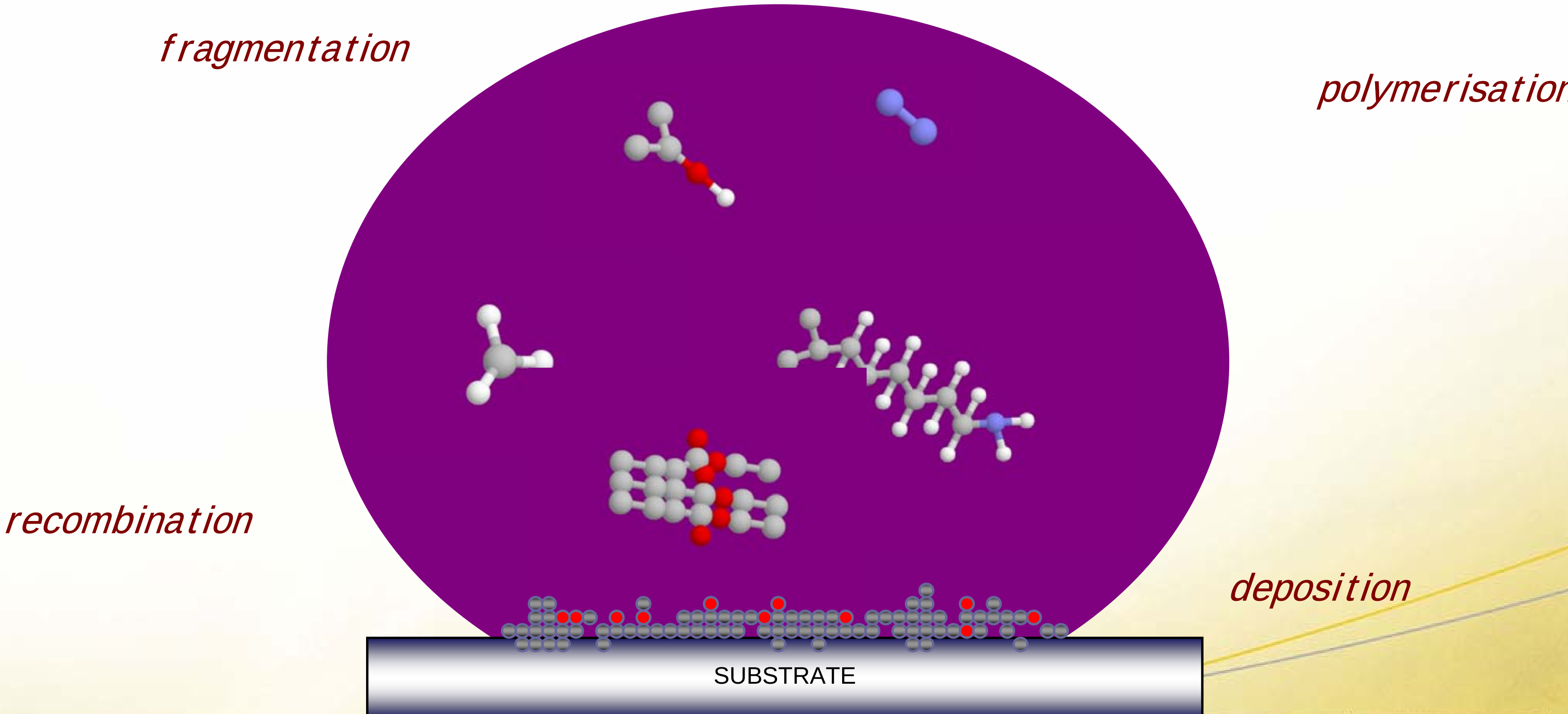
- Adhesion enhancement of polymeric substrates
  - Introduction
  - Characterization & Results
  - Conclusions
- Release coatings
  - Introduction
  - Characterization & Results
  - Conclusions
- General conclusions

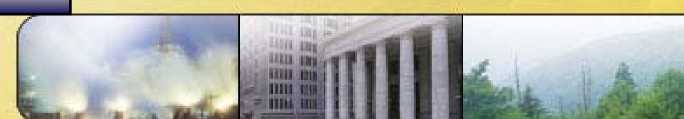


INTRODUCTION

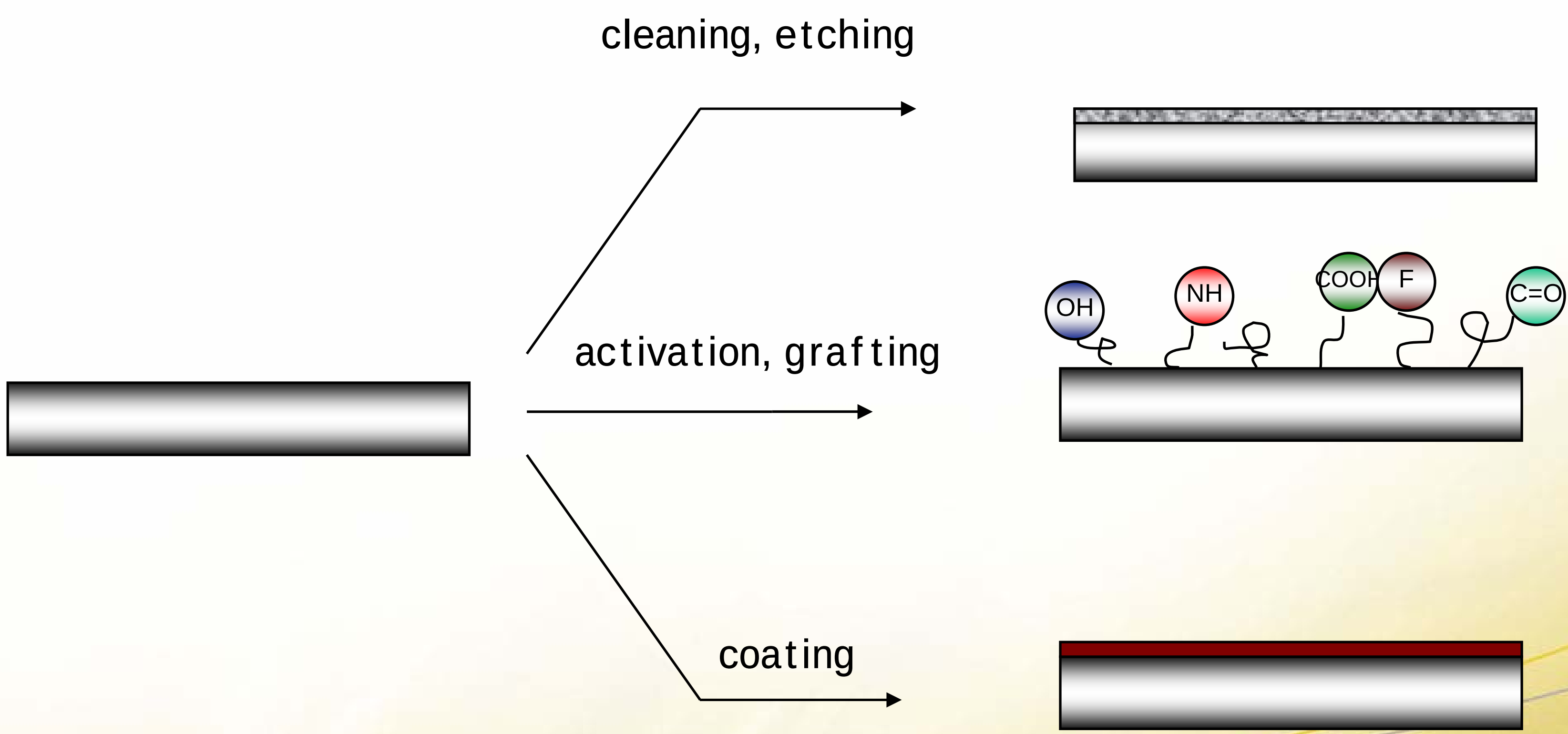


Surface modification using plasma technology





Surface modification using plasma technology



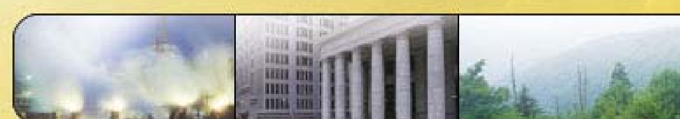
Surface modification using plasma technology

Plasma assisted surface engineering

- Etching and cleaning (micro electronics, steel, glass, ...)
- Sterilization (biomedical, military, ...)
- Activation (plastics, textiles, steel, glass, paper, ...)
- Deposition of (multi) functional coatings (antimicrobial, scratch resistance, low friction, corrosion protection ...)

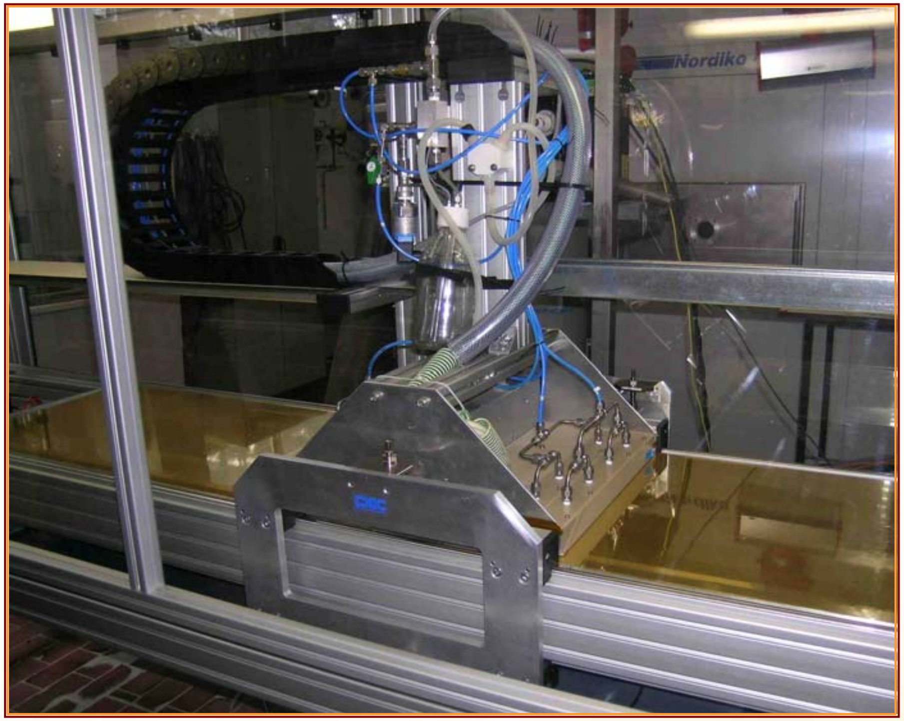
Advantages

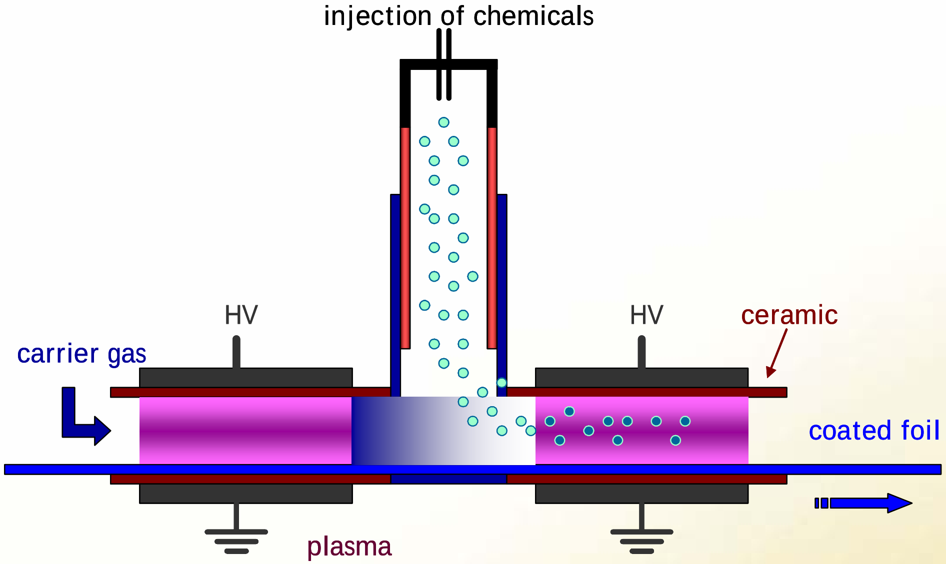
- Environmental friendly
- Allows to deposit coatings with unique properties
- Flexible switching between process conditions
- Reliable operation
- Energy efficient



EQUIPMENT

PlasmaZone®

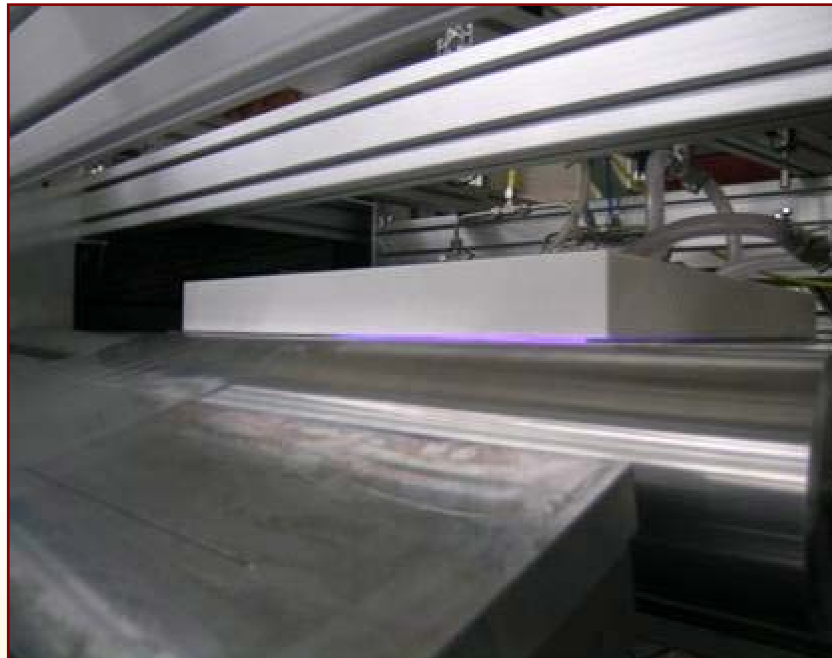




- Carrier gas: N_2, He, Ar, O_2, CO_2 (air), CF_4, SF_6,…
- Frequency range: 1–100kHz
- High voltage range: 1–100 kV
- Gaz consumption: 5-50L/min
- Power: 10-1000W
- Dissipated power: ≤ 1 W/cm2
- Temperature range: 25-250°C (~60-70°C)
- Gap ~ 2mm

PlasmaZone®

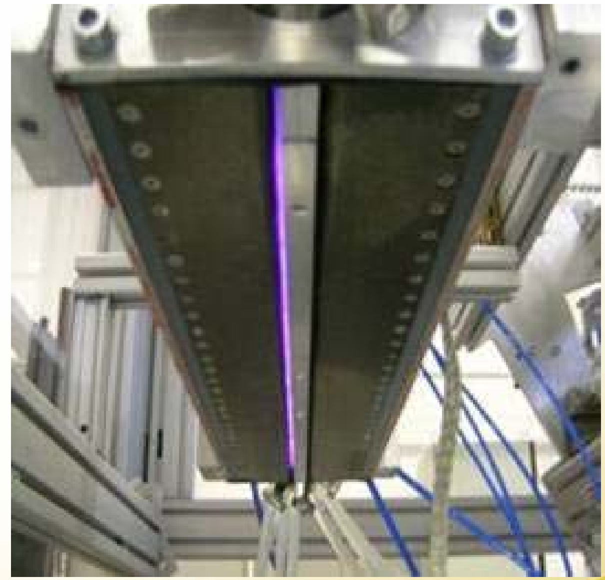
Semi-industrial roll-to-roll DBD plasma treatment



- Plasma treatment zone > 100cm
- Width max.: 600mm
- Speed: 1-200m/min
- Power: 500 – 1000W

PlasmaSpot® - PlasmaLine®

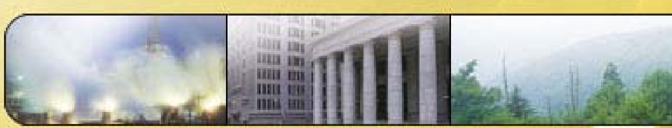
- Indirect plasma (after glow)



PlasmaLine®

PlasmaSpot®

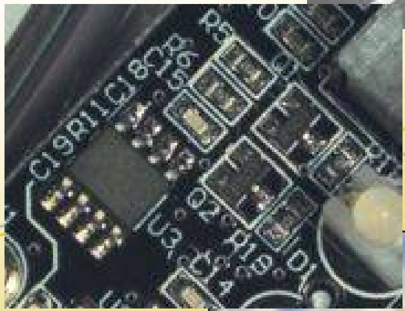
ADHESION ENHANCEMENT



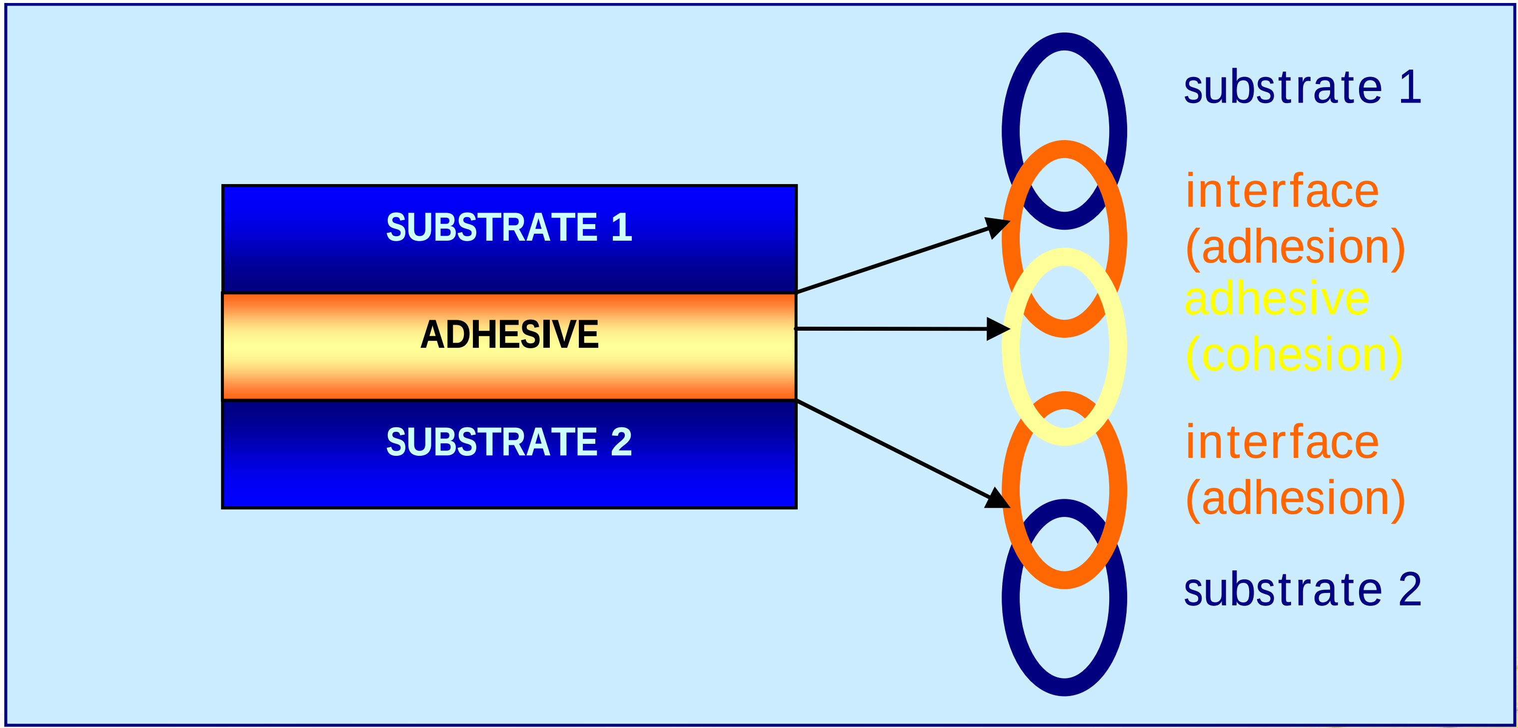
Introduction on Adhesion

- Present everywhere in the nature
- Among the oldest technologies
- 1st developments in chemistry in early 1900's
- Today
  - More than 1500 adhesives manufacturers
  - Total consumption in 2005: 6.10^6 ton





Introduction on Adhesion



Characterization & Results

Chemistry

$CH_2{=}CH{-}C({=}O){-}O{-}CH_2CH_2{-}OH$

hydroxyethyl acrylate (HEA)

$CH_3{-}C({=}O){-}O{-}CH_2CH_3$

ethyl acetate

$CH_2{=}CH{-}CH_2{-}NH_2$

allylamine (AAm)

N_2 / (CO_2) gas activation

$CH_2{=}CH{-}COOH$

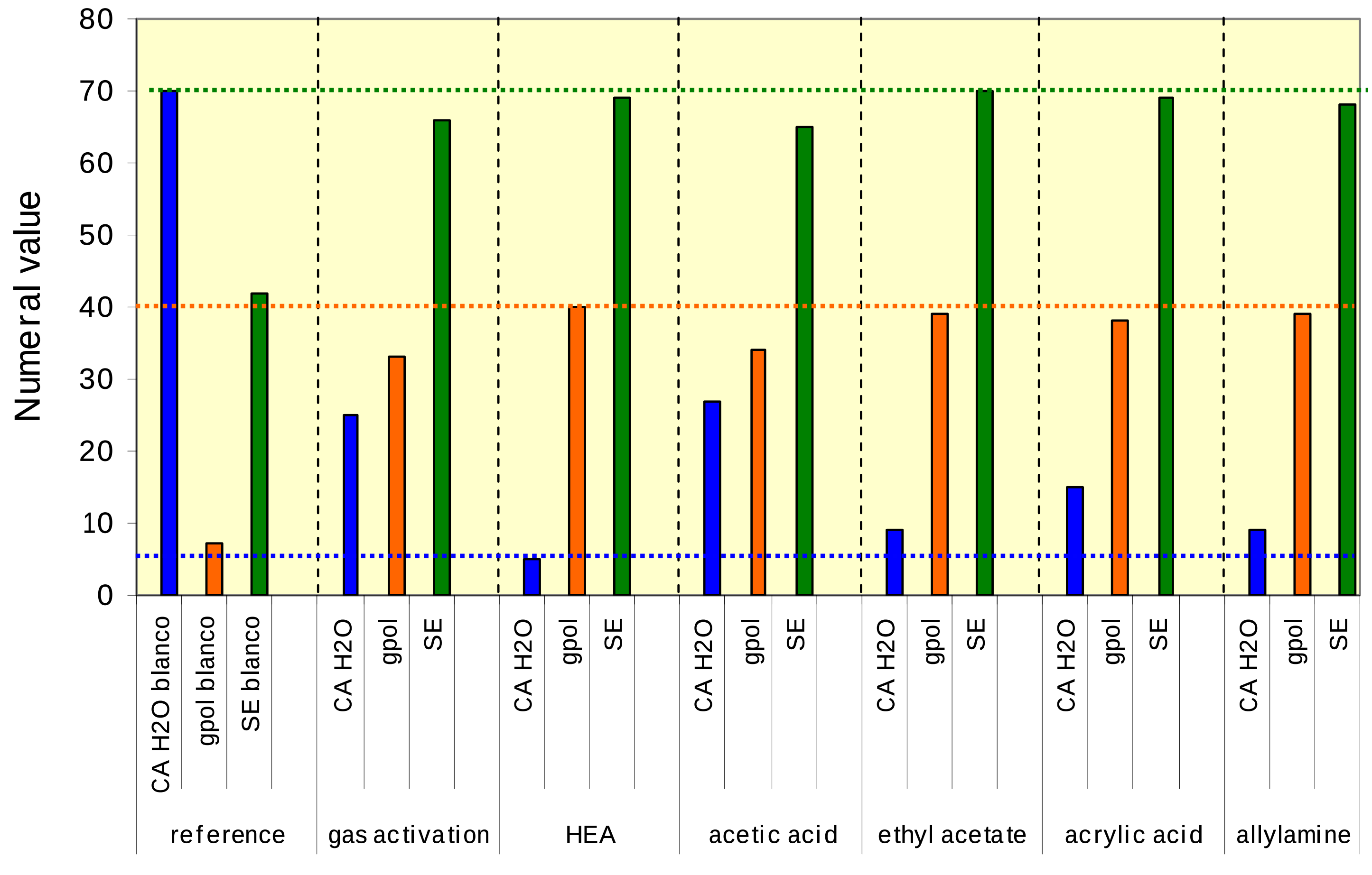
acrylic acid (AA)

$CH_3{-}COOH$

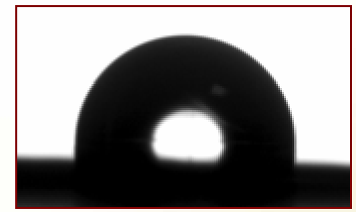
acetic acid

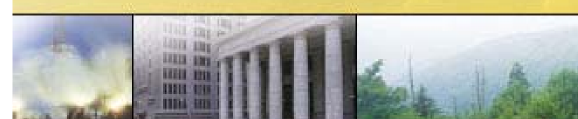
Characterization & Results

Surface tension parameters: *1 month after plasma treatment*



Polyethylene
(OW method)

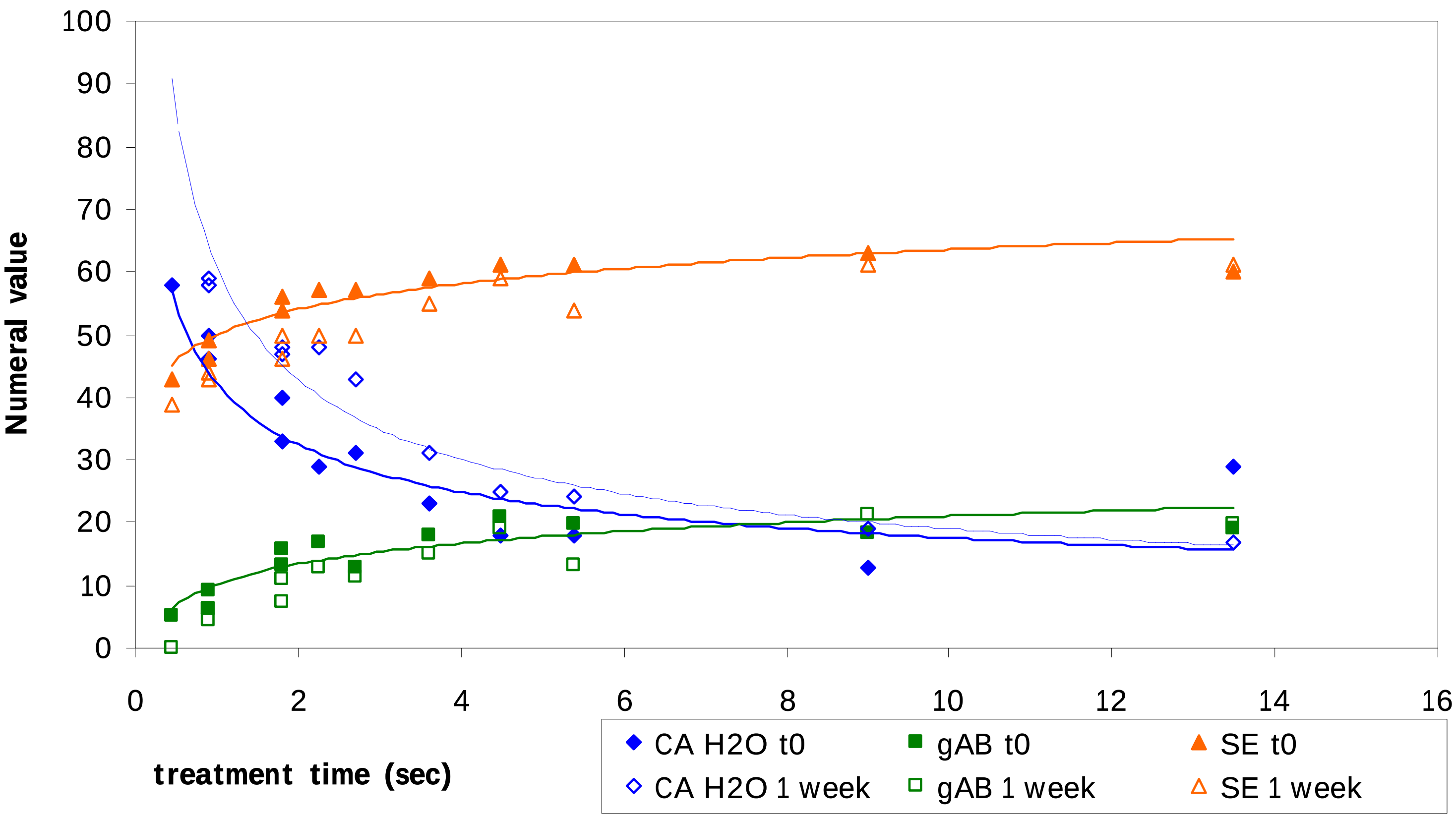




Characterization & Results

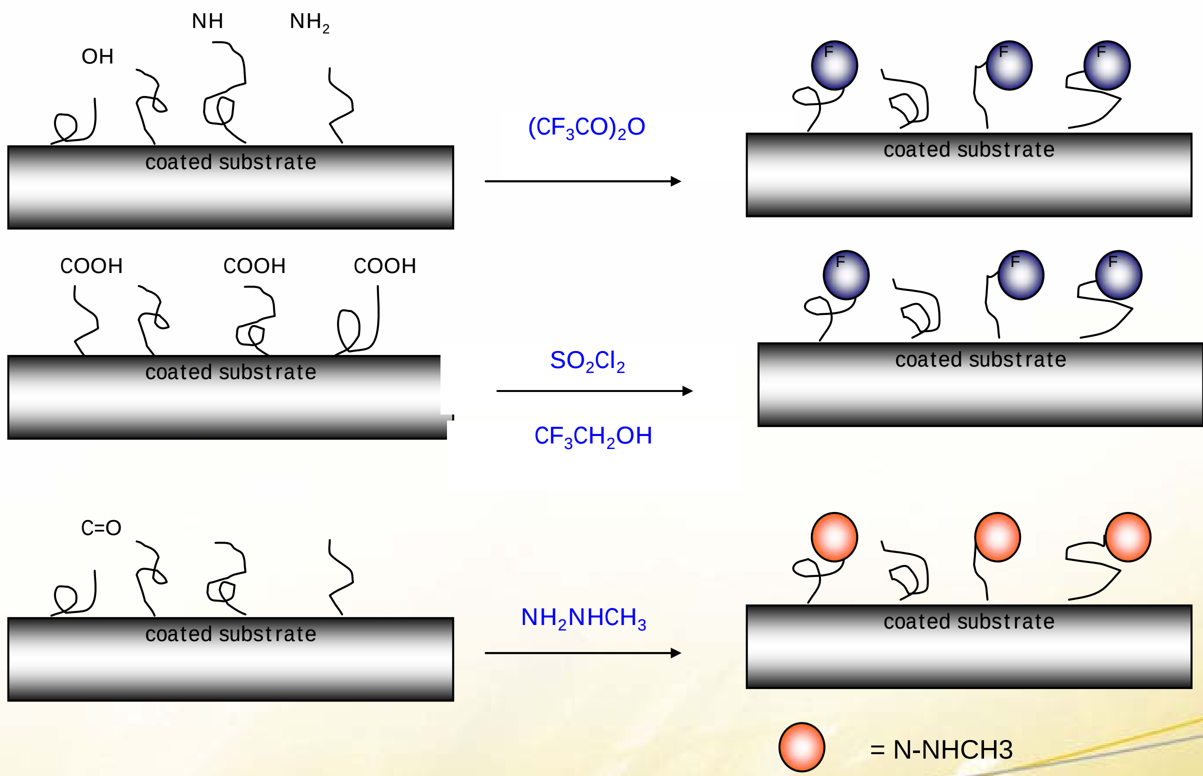
Surface tension parameters: *influence of treatment time*

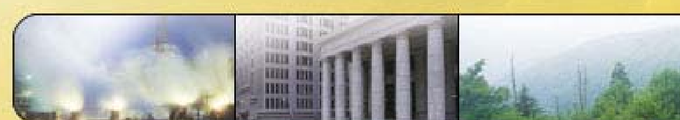
Polypropylene
(acid-base method)



Characterization & Results

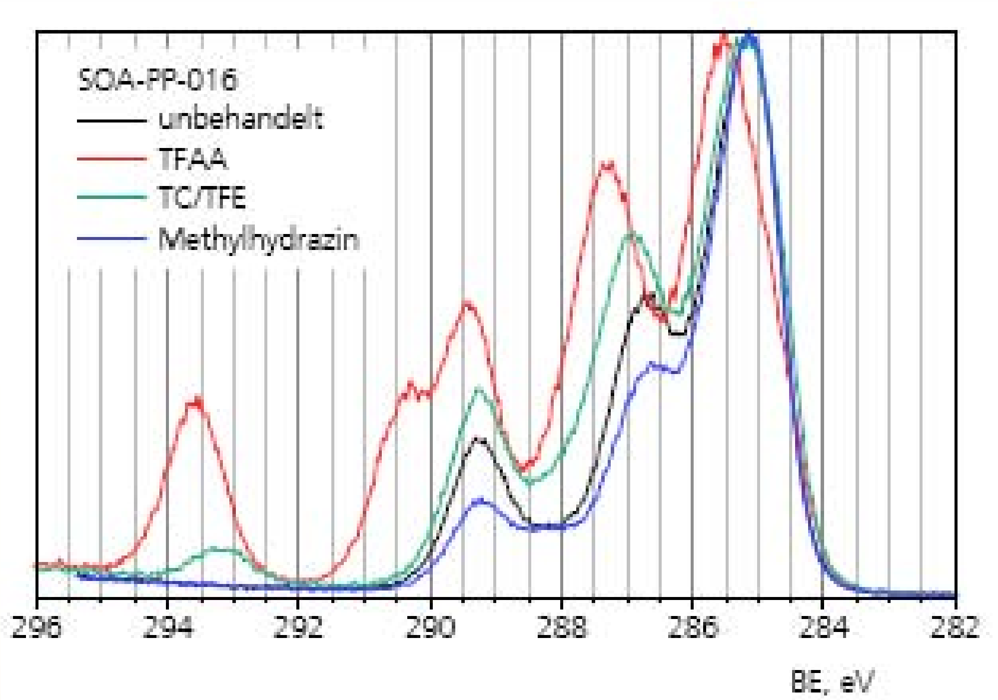
Structure analysis: *labeling coupled XPS*



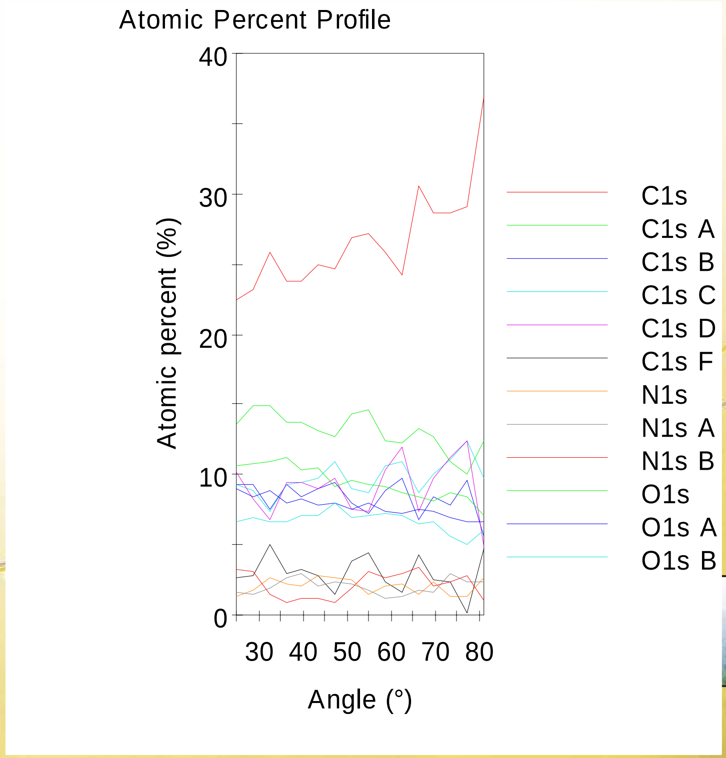


Characterization & Results

Structure analysis: *labeling coupled XPS*



HEA-based plasma coating on Polypropylene



[OH], [NH_2] ~15%

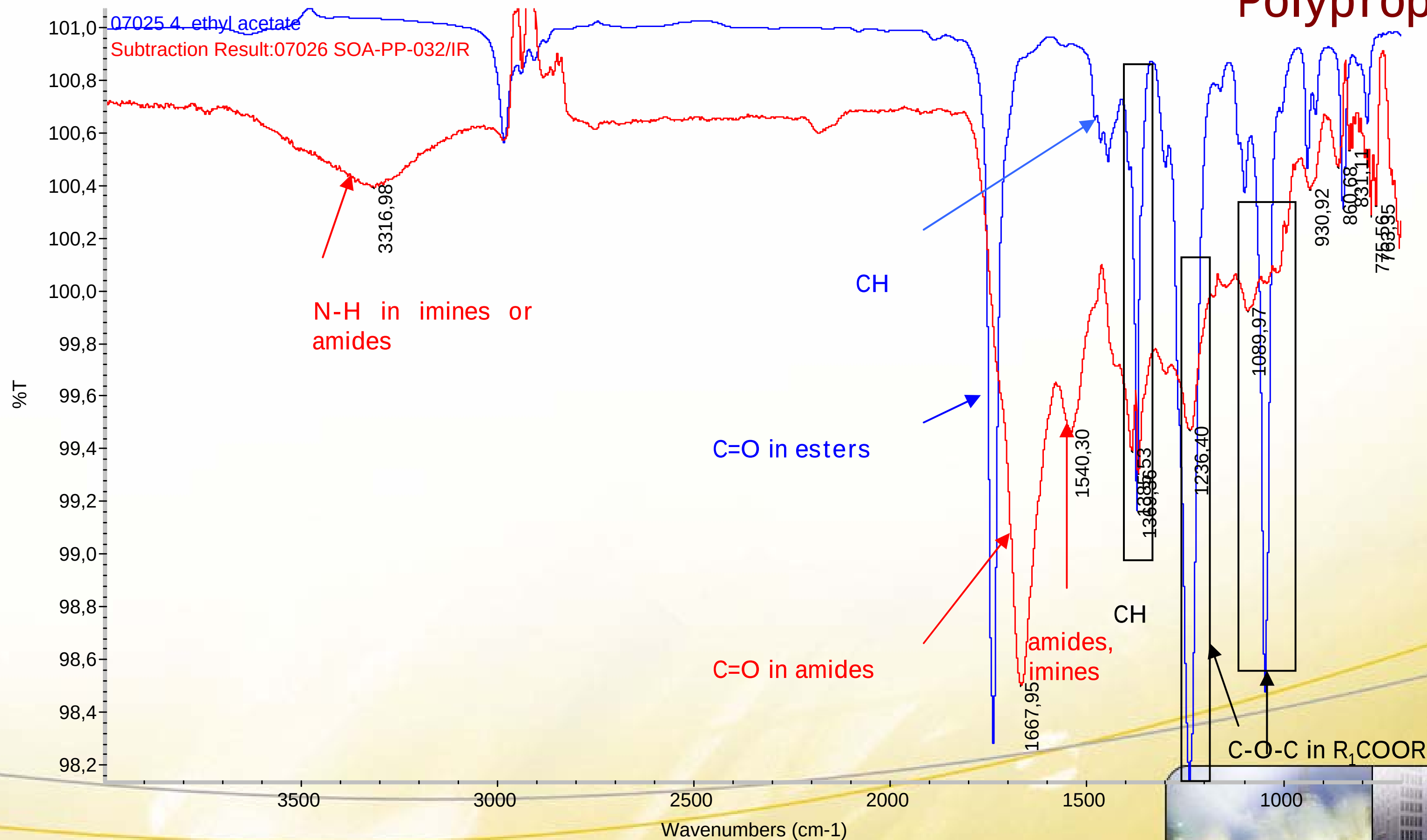
[COOH] ~2.6%

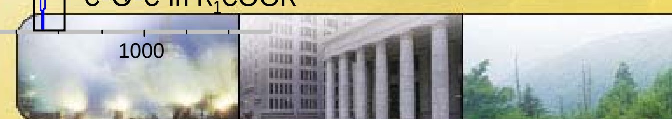
[C=O] ~2.3%

Characterization & Results

Structure analysis: *ATR-IR*

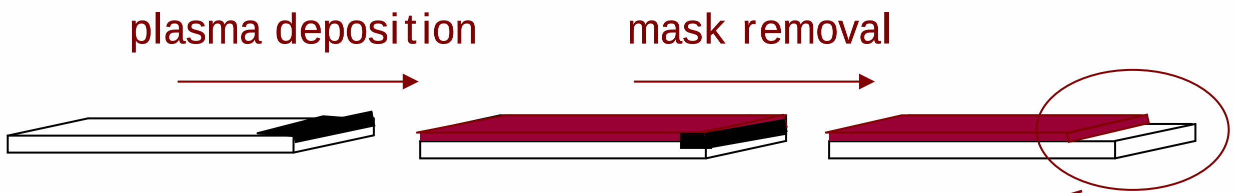
EtAc-based plasma coating on Polypropylene

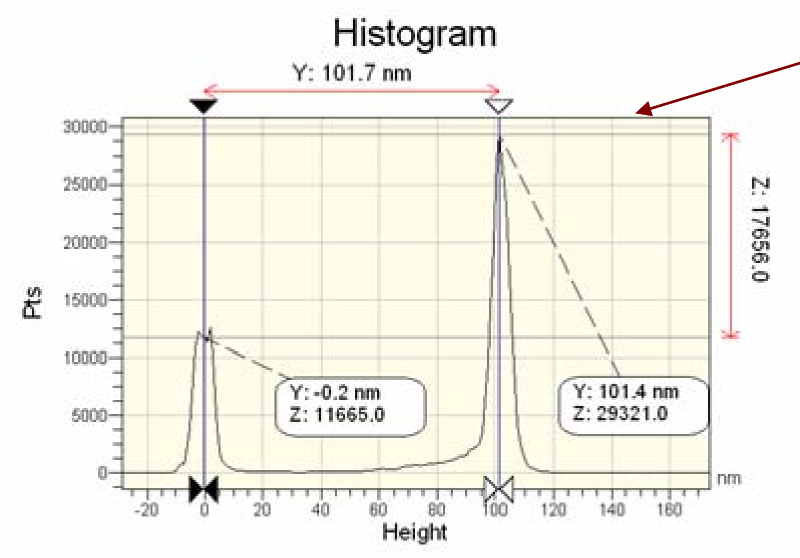


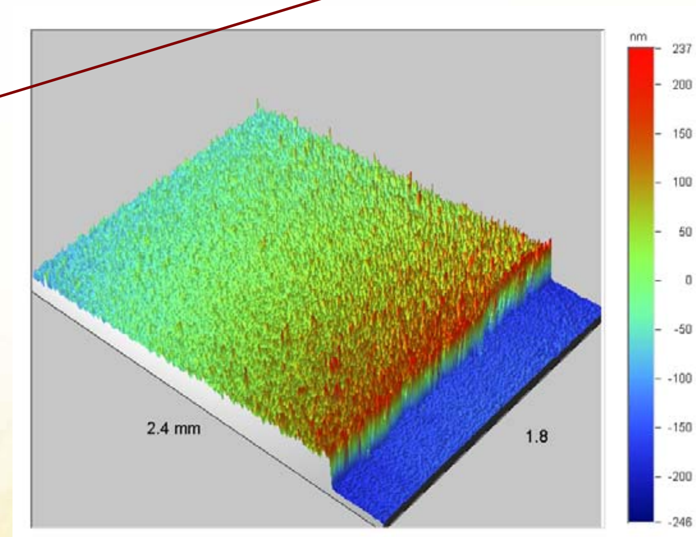


Characterization & Results

Coating thickness & roughness: *profilometry*







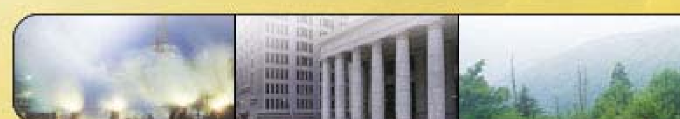
Conclusions

- Controlled and functional coating deposition via atmospheric pressure plasma

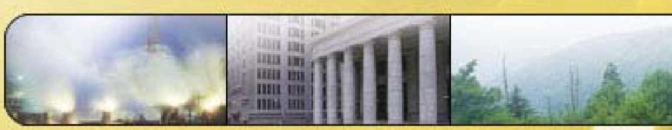
- Control of the surface tension parameters

- Re-organization of the precursor structure in the plasma ➥ new functions created

- Applications:
  - Primer replacement
  - Enhancement of a substrate printability
  - Enhancement of the adhesion with a glue,
  - …



RELEASE COATINGS



Introduction on Release coatings

- Most important market: PSA
- 1st development in the XIXth century: surgical tape
- Drastic development of PSA since beginning 1900's
- Applications: mold release (lubricants), masking tapes, PSA tapes, labels,...



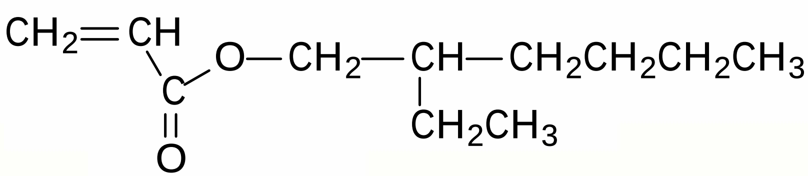
Introduction on Release coatings

- wet chemical deposition, plasma-assisted chemical vapour deposition, gas fluorination, powder coating,... .
  - Cost issue
  - Environmental issue
  - ...

Characterization & Results

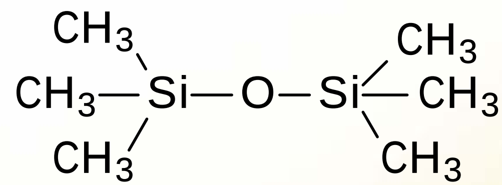
Chemistry

Silicon free chemistry



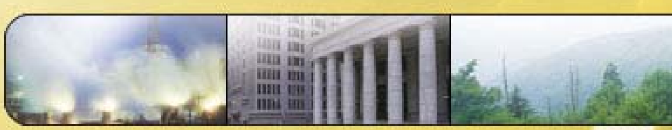
Ethylhexyl acrylate (EHA)

Silicon based chemistry



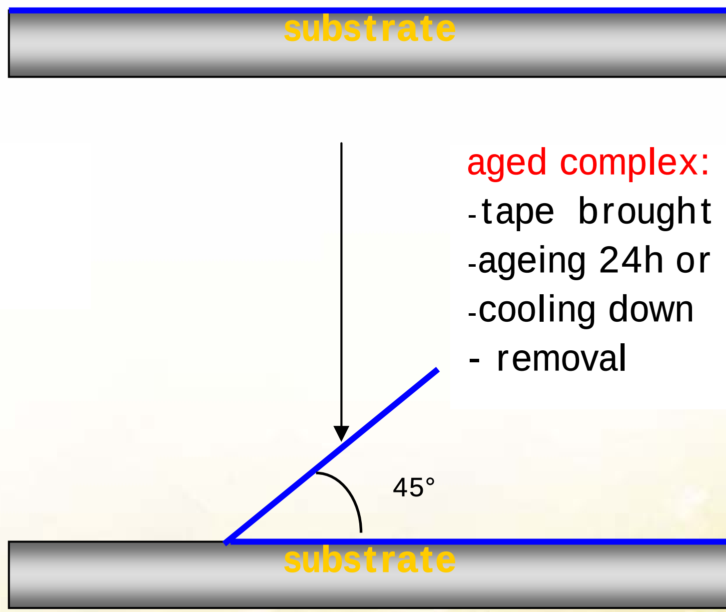
Hexamethyldisiloxane (HMDSO)

Development in collaboration with Nitto Europe



Characterization & Results

Release properties: release tests

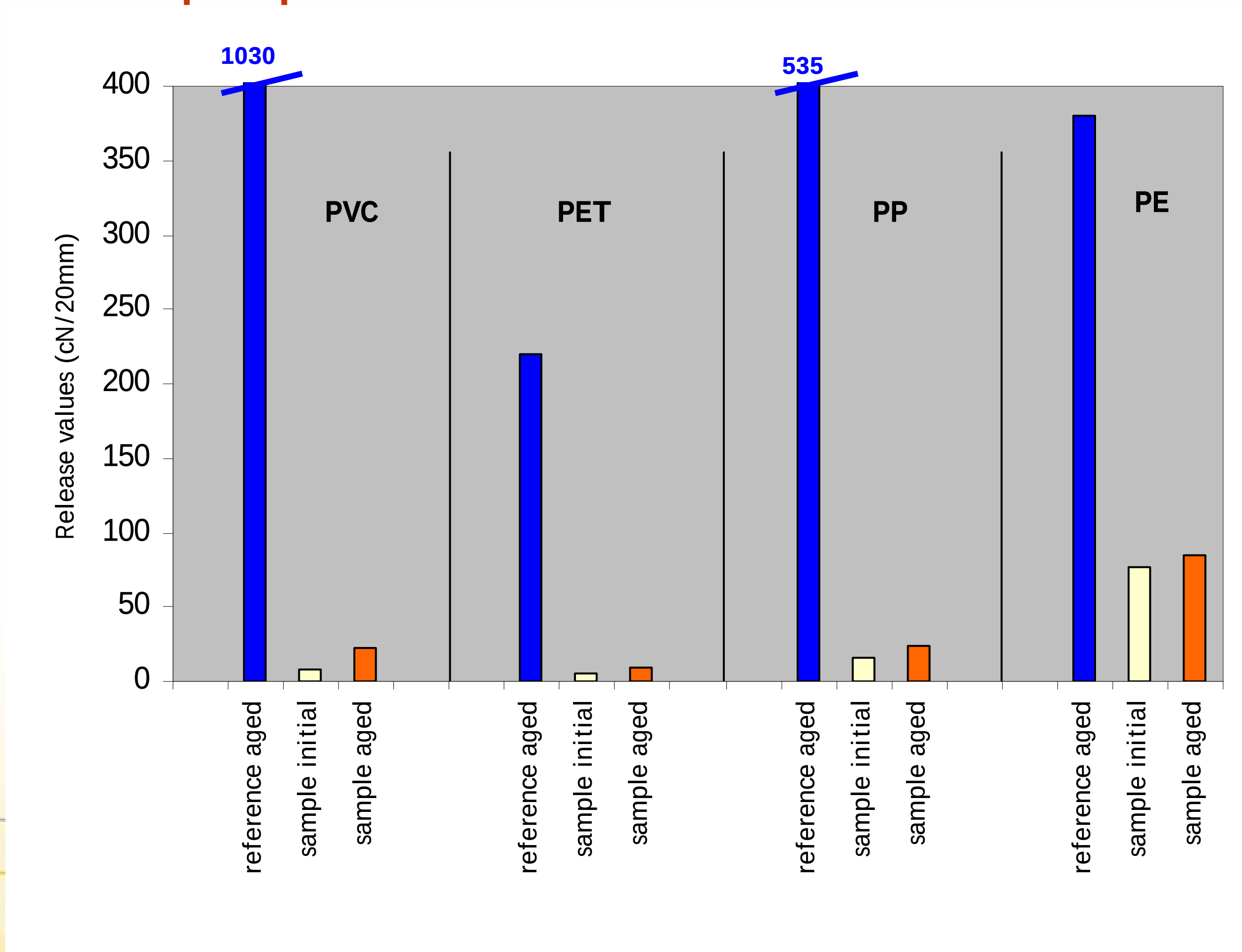


initial:
- tape brought at RT
- removal after 2 hours

aged complex:
- tape brought at RT
- ageing 24h or 1 week at 60°C
- cooling down
- removal

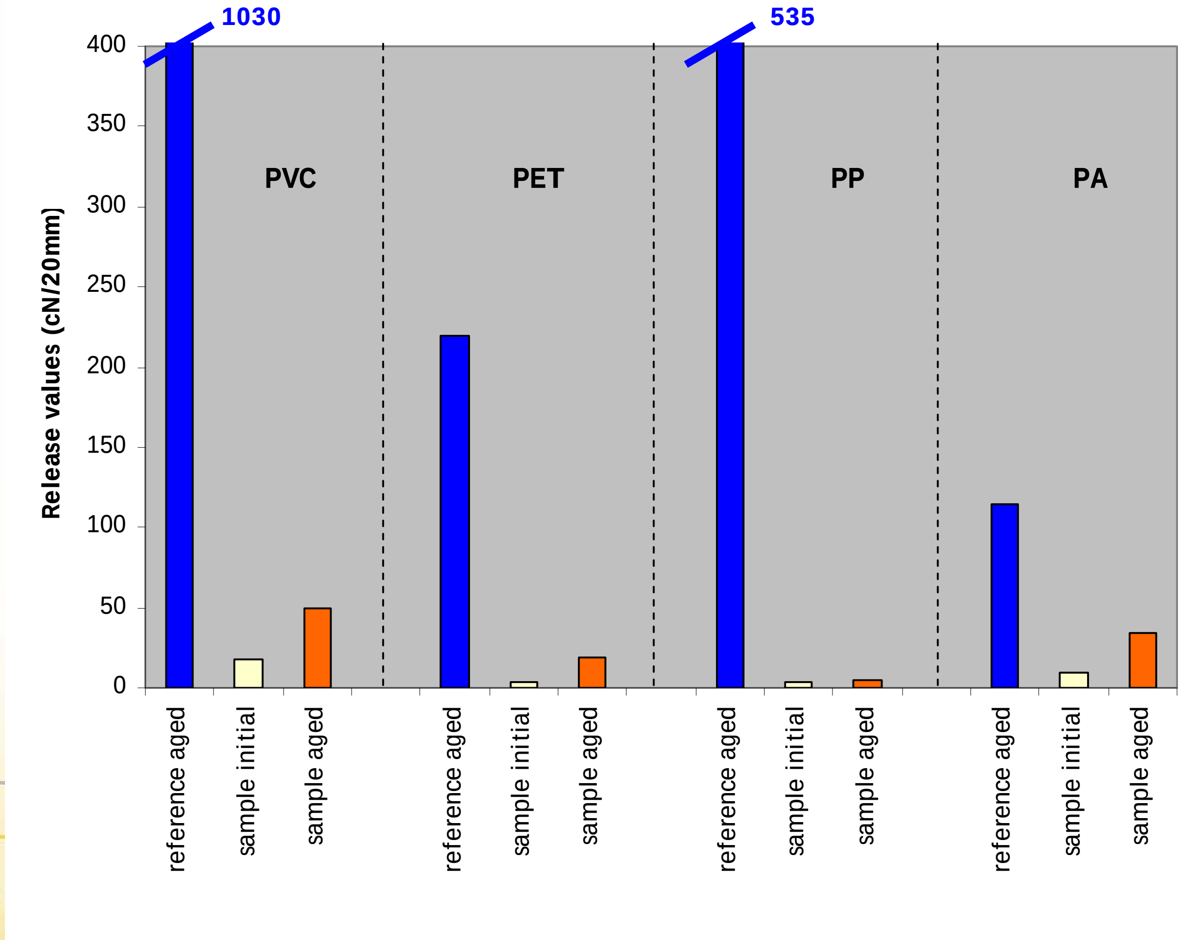
Characterization & Results

Release properties: release tests EHA



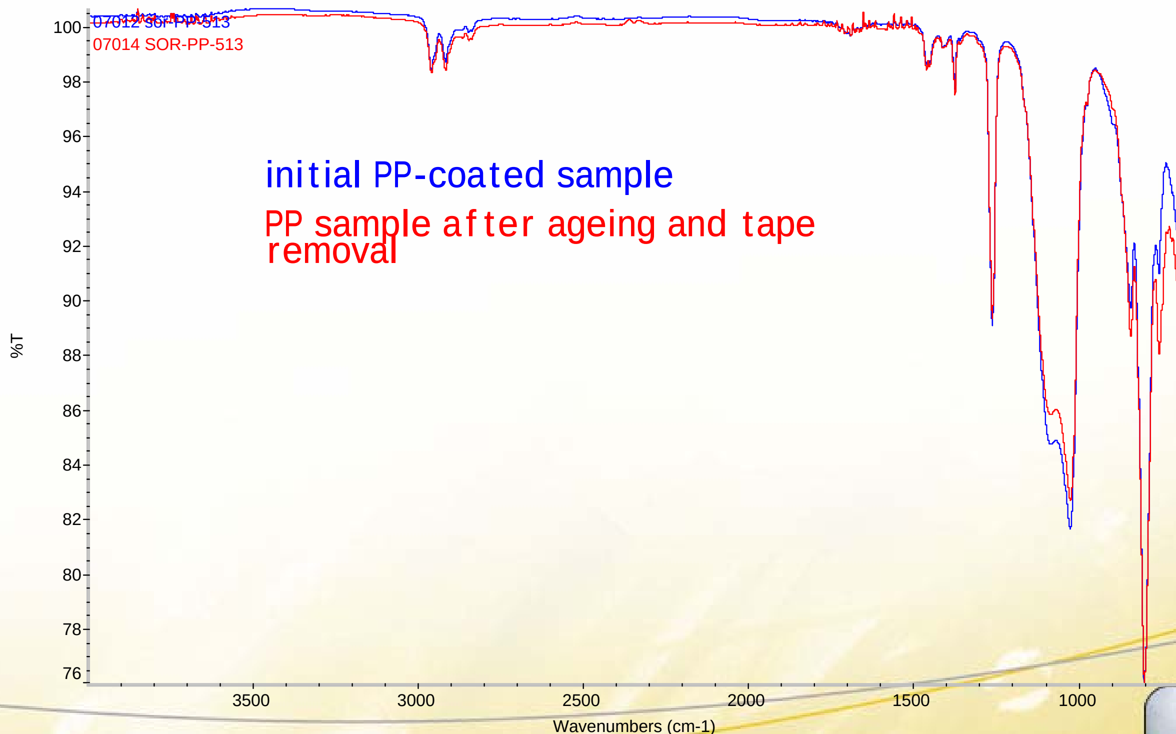
Characterization & Results

Release properties: release tests HMDSO

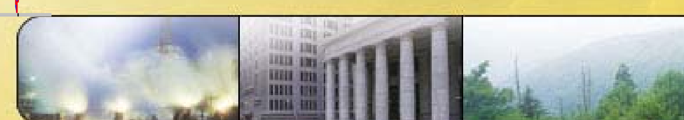


Characterization & Results

Structure evaluation: ATR-IR - HMDSO

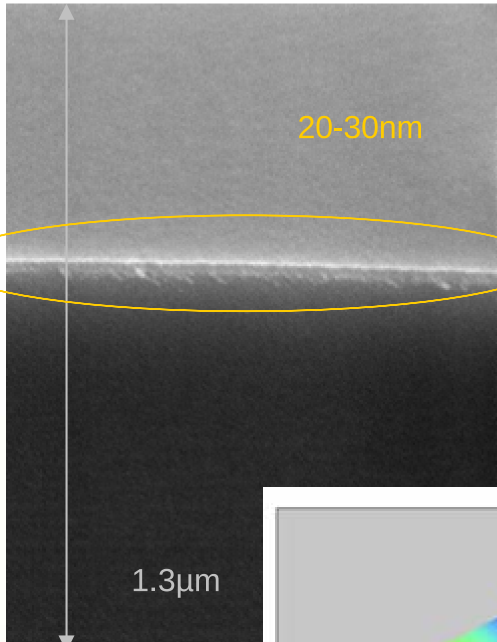


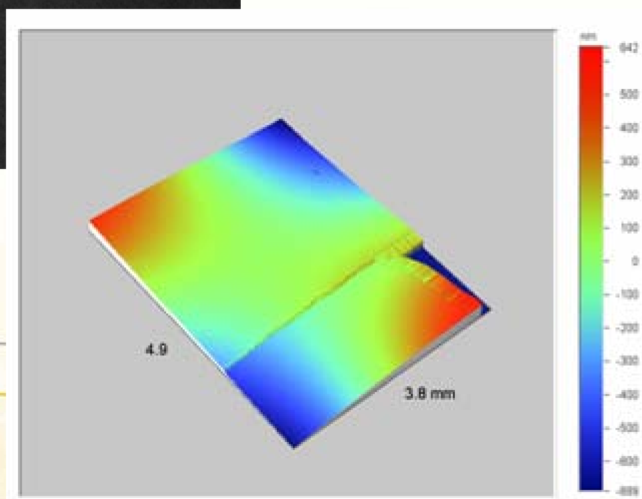
- No silicon transfer to the tape



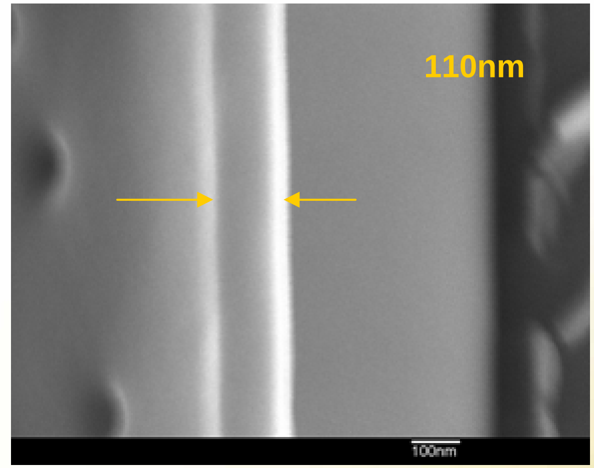
Characterization & Results

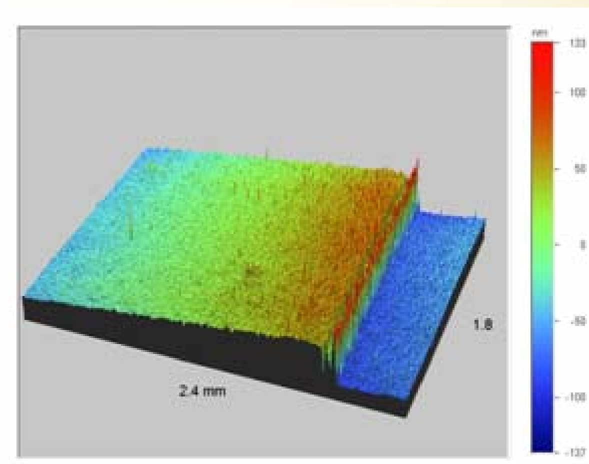
Thickness: SEM, profilometry





EHA





HMDSO

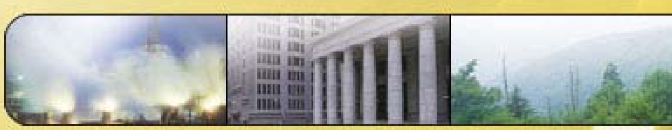
Conclusions

- Controlled and functional coating deposition via atmospheric pressure plasma:
  - Apolar silicon-free acrylate coatings
  - Silicon-based caotings
- Drastic improvement of the release properties
- Applications:
  - Release liner for preesure-sensitive adhesive tape
  - Mold release
  - Labels
  - …

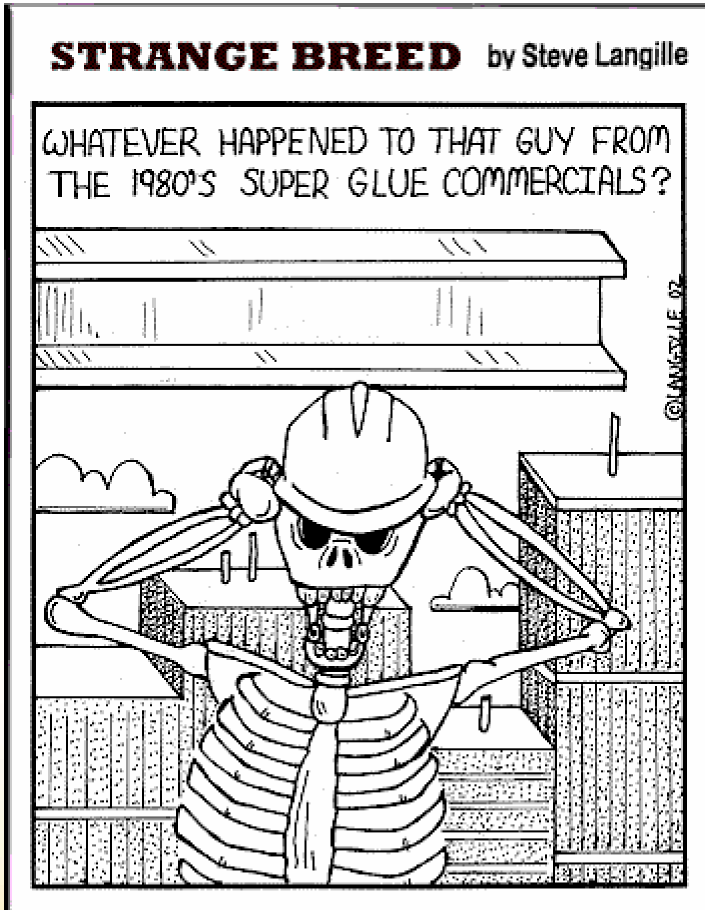
GENERAL CONCLUSIONS

Conclusions

- Atmospheric DBD plasma processes, based upon the same technology as current state of the art corona technology, offer new possibilities for sustainable dry surface engineering.
- By controlling the gas atmosphere and the electrical conditions and by addition of reactive chemicals, one can increase the efficiency of the plasma surface treatment significantly and make the effects permanent.
- The technology opens up new possibilities to deposit thin functional coatings in a continuous system at ambient pressure.
- Efficient tuning of the final properties.



Questions ???


STRANGE BREED by Steve Langille
WHATEVER HAPPENED TO THAT GUY FROM THE 1980'S SUPER GLUE COMMERCIALS?
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