קורס דבקים. פרק ב.
פריימרים והכנות שטח

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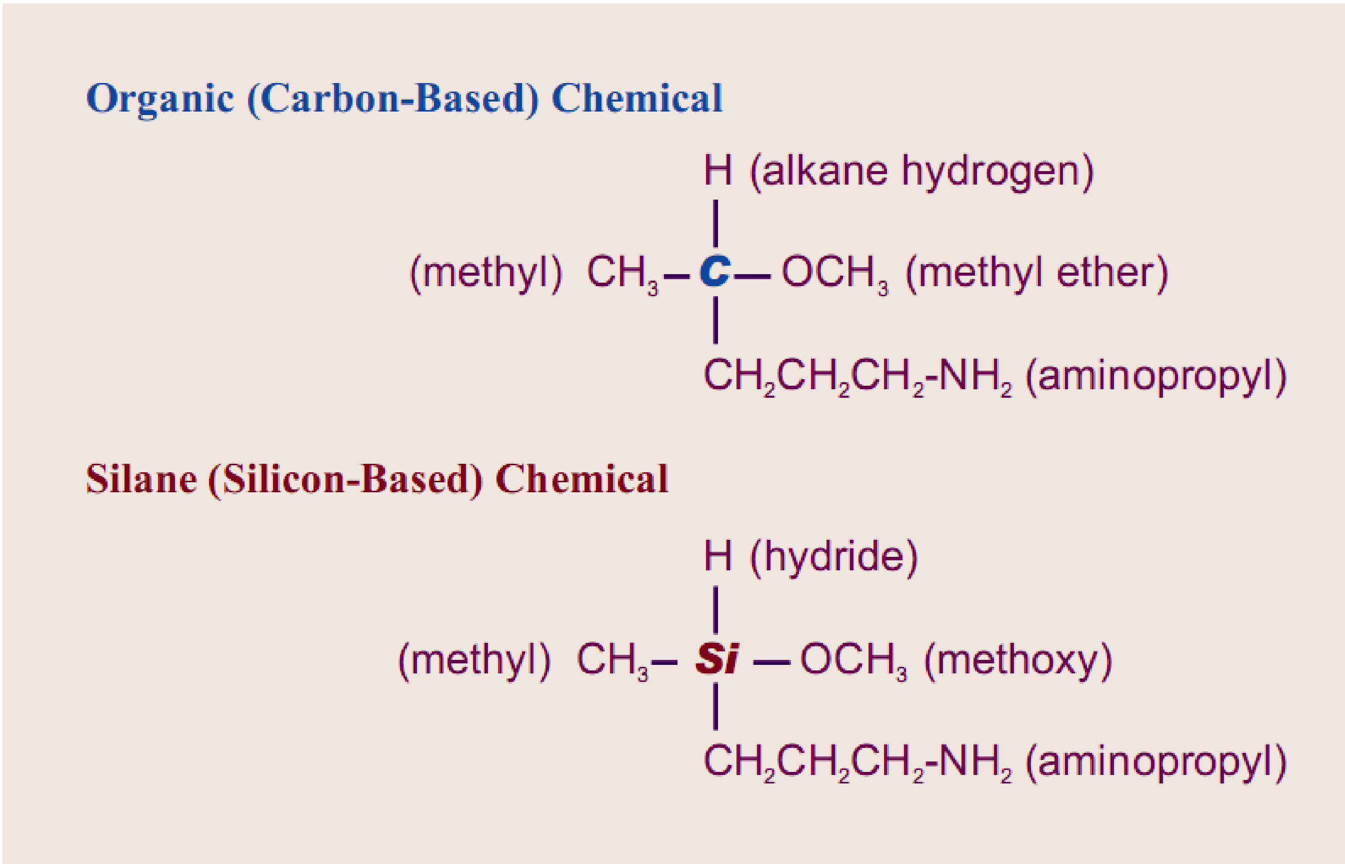
פריימרים

- פריימר הוא ציפוי דק, המיושם על מצע, לאחר שנוקה כהלכה, ומשפר את ההרטבה והחיבור של דבק למצע
- במקרים מיוחדים, הפריימר משמש לצורך הגנה על שטח הבין פנים מפני קורוזיה
- פריימר, מורכב בדרך כלל מ:
  - ממס
  - חומרים משפרי הרטבה (לא תמיד)
  - משפרי הדבקה (בדרך כלל סילאנים, אבל יכולים להיות גם טיטאנטים, זירקונאטים ופולימרים עם מספר חומצה גבוה)
  - פיגמנטים אנטי קורוזיביים (כאשר הפריימר מיועד להגנה על מתכות רגישות לקורוזיה)
  - פולימרים (לא תמיד)

סילאנים

Figure 1. Carbon vs. silicon chemistry.



סילאנים

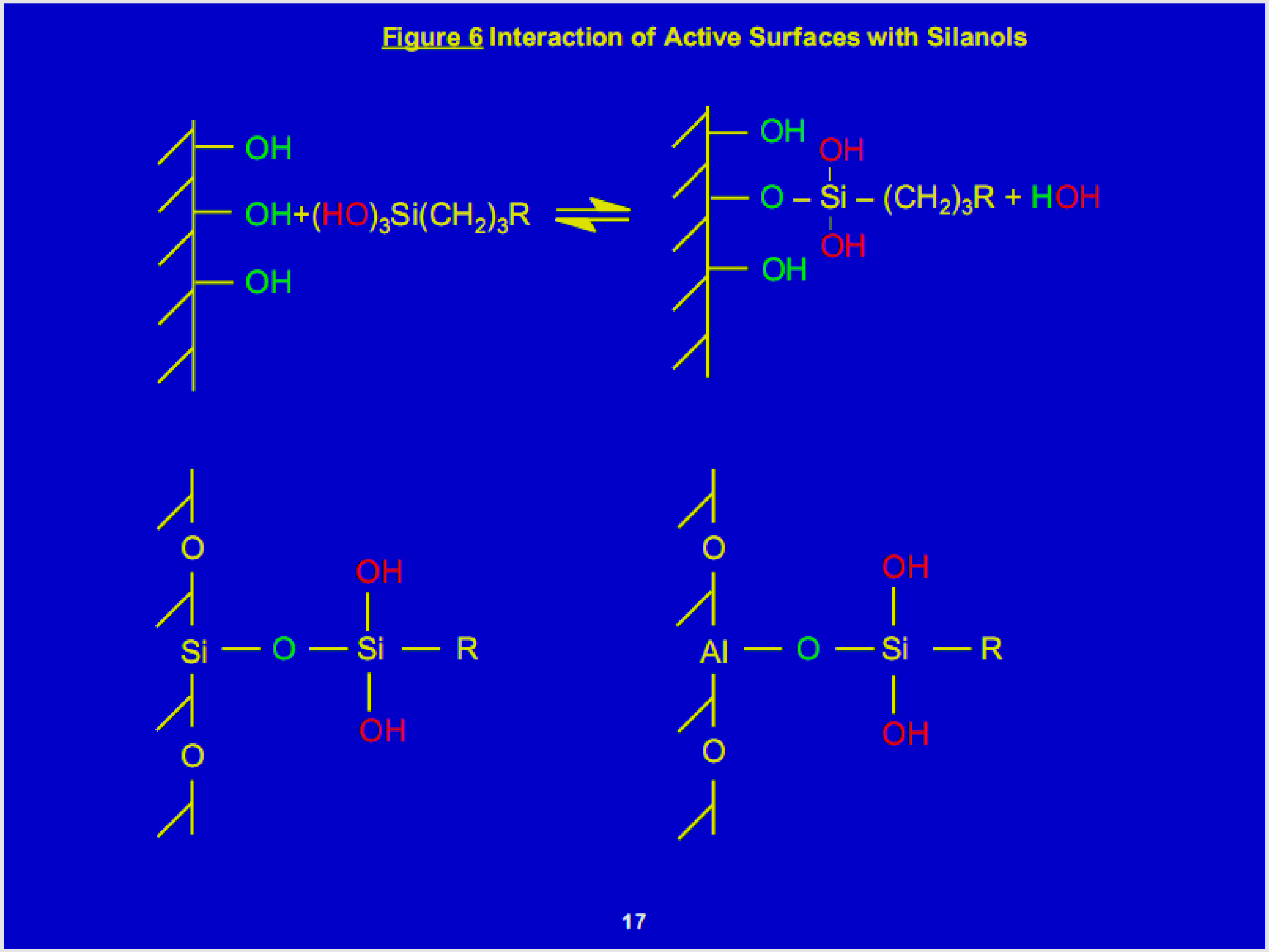


Figure 6 Interaction of Active Surfaces with Silanols
OH
OH+(HO)3Si(CH2)3R
OH
OH
OH
O – Si – (CH2)3R + HOH
OH
OH
O
OH
Si — O — Si — R
OH
O
O
OH
Al — O — Si — R
OH
O
17

סילאנים

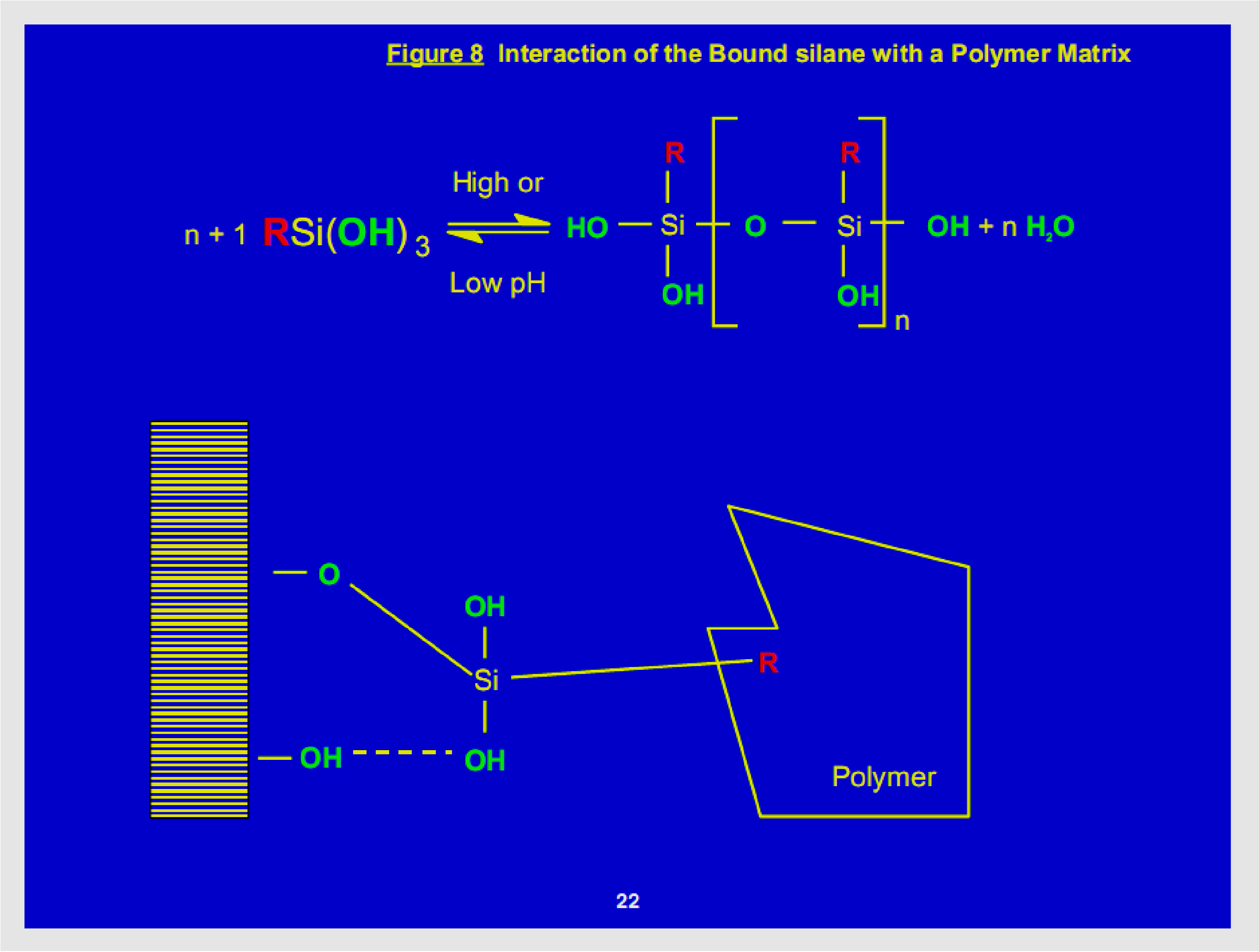


Figure 8 Interaction of the Bound silane with a Polymer Matrix
n + 1 RSi(OH) 3
High or
Low pH
HO
Si
O
Si
R
R
OH
OH
n
OH + n H2O
O
OH
Si
OH
OH
R
Polymer
22

סילאנים

Figure 2. The silane coupling mechanism.

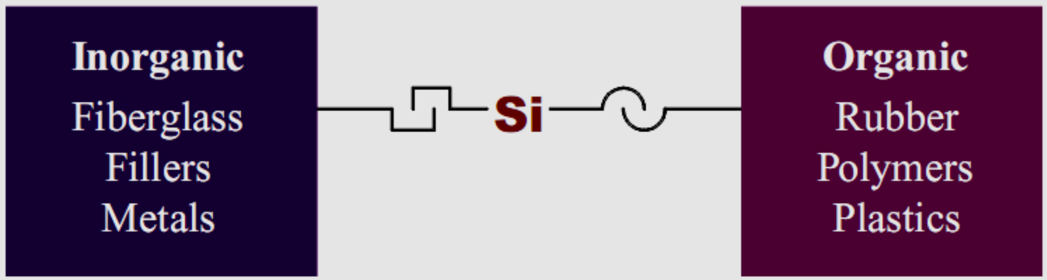
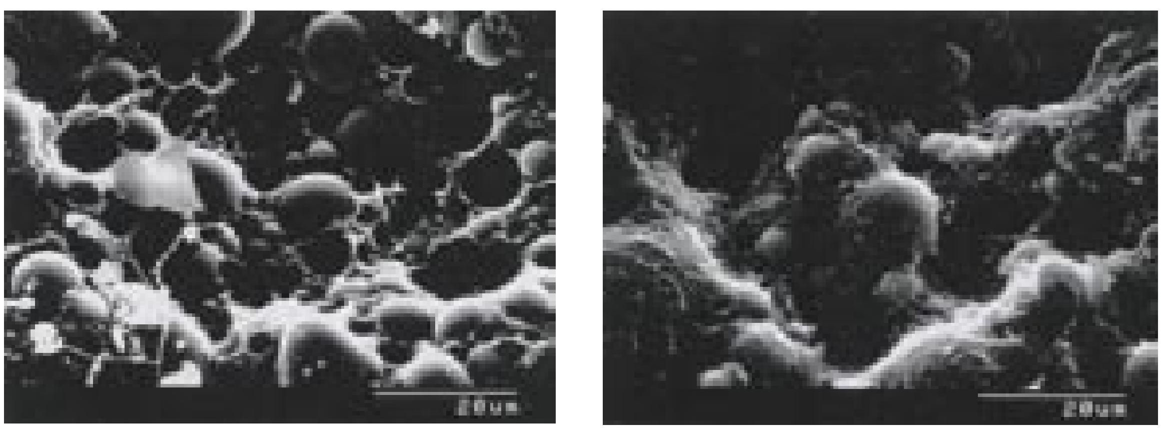


Figure 3. SEM of silica-filled epoxy resin.



Without Silane **With Silane**

סילאנים

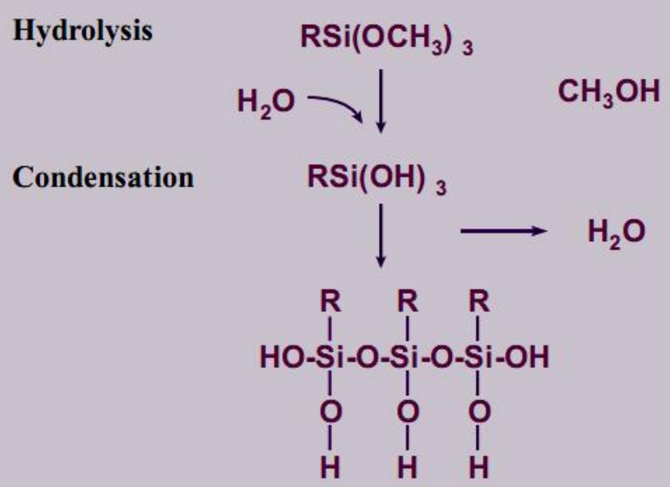


Figure 4. Hydrolysis of alkoxysilanes.

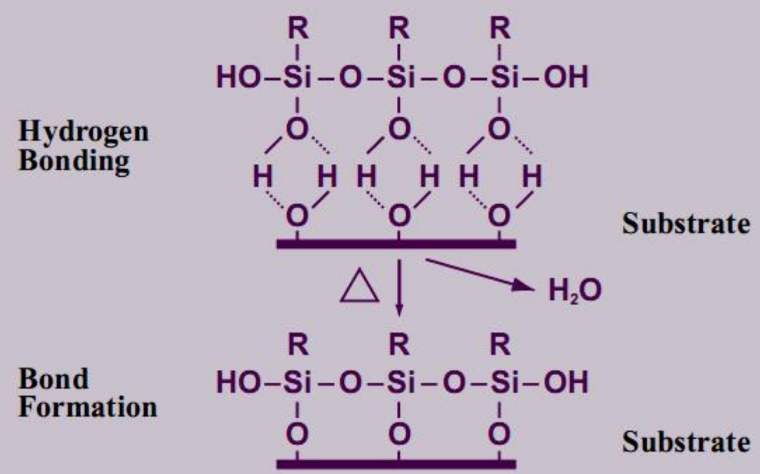
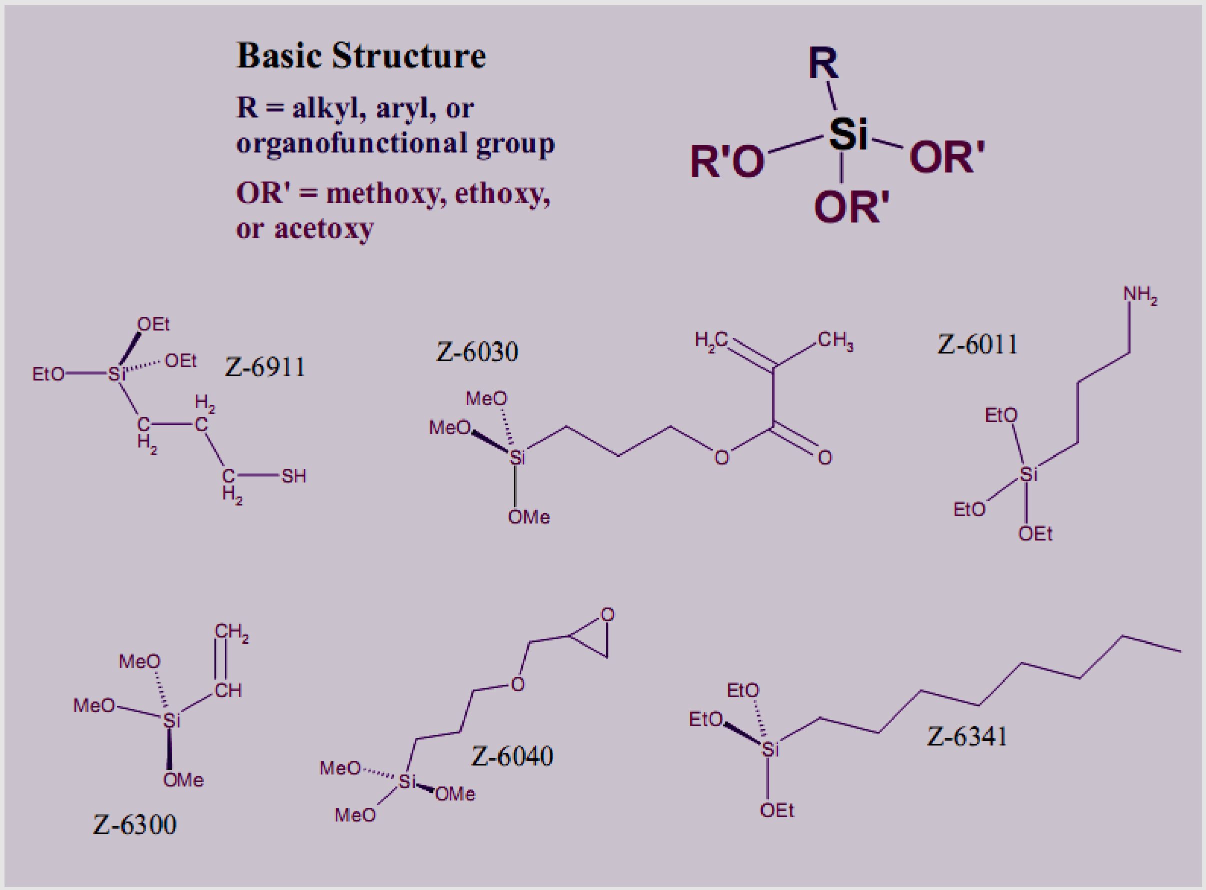


Figure 5. Bonding to an inorganic surface.

סילאנים

Figure 7. Silane coupling agent variations – basic structure.



סילאנים עם קבוצות פעילות שונות

Dow Corning® brand Silane	Organic Reactivity	Application (suitable polymers)
Z-6011	Amino	Acrylic, Nylon, Epoxy, Phenolics, PVC, Urethanes, Melamines, Nitrile Rubber
Z-6020	Amino	Acrylic, Nylon, Epoxy, Phenolics, PVC, Melamines, Urethanes, Nitrile Rubber
Z-6028	Benzylamino	Epoxies for PCBs, Polyolefins, All Polymer Types
Z-6030	Methacrylate	Unsaturated Polyesters, Acrylics, EVA, Polyolefin
Z-6032	Vinyl-benzyl-amino	Epoxies for PCBs, Polyolefins, All Polymer Types
Z-6040	Epoxy	Epoxy, PBT, Urethanes, Acrylics, Polysulfides
Z-6076	Chloropropyl	Urethanes, Epoxy, Nylon, Phenolics, Polyolefins
Z-6094	Amino	Acrylic, Nylon, Epoxy, Phenolics, PVC, Melamines, Urethanes, Nitrile Rubber
Z-6106	Epoxy/Melamine	Epoxy, Urethane, Phenolic, PEEK, Polyester
Z-6128	Benzylamino	Epoxies for PCBs, Polyolefins, All Polymer Types
Z-6137	Amino	Acrylic, Nylon, Epoxy, Phenolics, PVC, Melamines, Urethanes, Nitrile Rubber (especially suited for water-based systems)
Z-6224	Vinyl-benzyl-amino	Epoxies for PCBs, Polyolefins, All Polymer Types
Z-6300	Vinyl	Graft to Polyethylene for Moisture Crosslinking, EPDM Rubber, SBR, Polyolefin
Z-6376	Chloropropyl	Urethanes, Epoxy, Nylon, Phenolics, Polyolefins
Z-6518	Vinyl	Graft to Polyethylene for Moisture Crosslinking, EPDM Rubber, SBR, Polyolefin
Z-6675	Ureido	Asphaltic Binders, Nylon, Phenolics; Urethane
Z-6910	Mercapto	Organic Rubber
Z-6920	Disulfido	Organic Rubber
Z-6940	Tetrasulfido	Organic Rubber

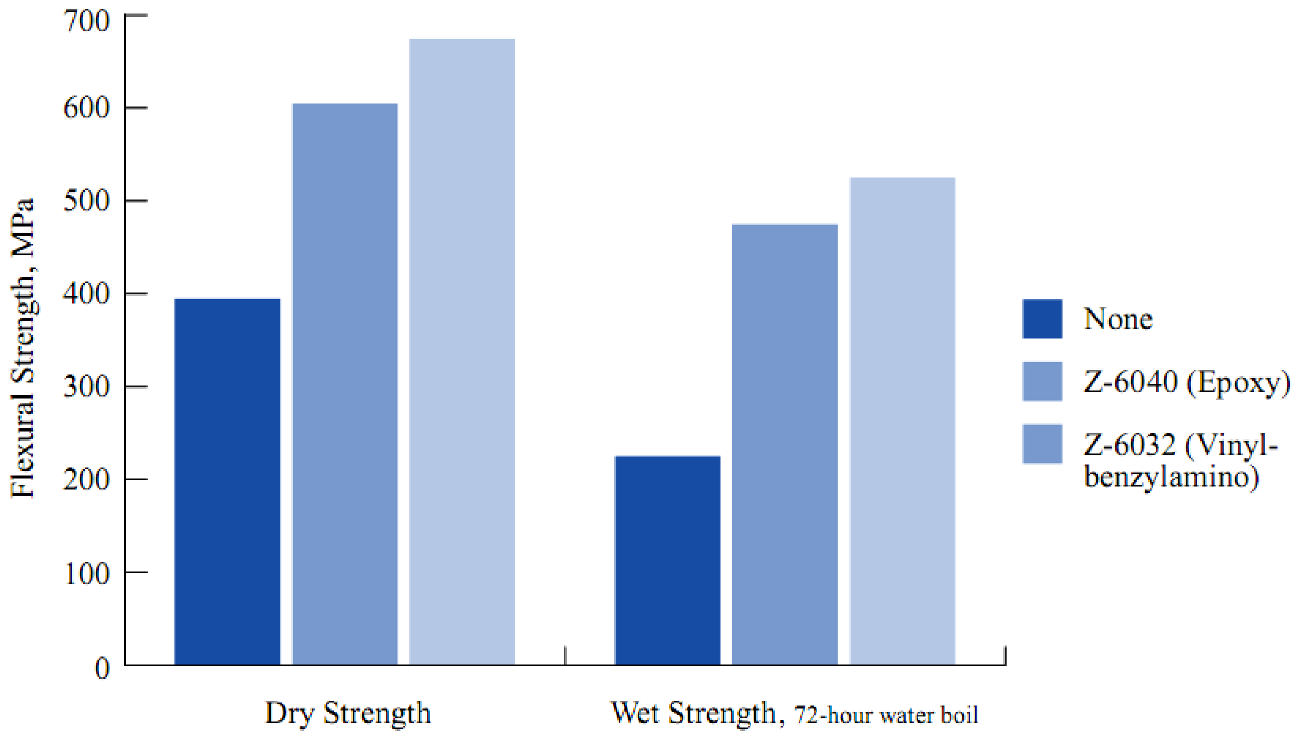
סילאנים

Table 4: Selection of silane adhesion promoters

Organofunctional group of the silane adhesion promoter	Recommended for the following polymers
Amino	Epoxy, phenol, melamine, furan, urea, PVC, urethane, polyvinylbutyral, polyimide, polychloroprene, nitrile rubber, etc.
Vinyl, methacryl	Unsaturated polyesters, EPDM, polyolefins, urethance, alkyd
Epoxy	Epoxy, phenol, epichlorohydrin, PVC, polyester, urethane, polysulphide
Mercapto	All elastomers, urethance, polysulphide, PVC
Urea	Phenol, urea or melamine resins, epoxy resins
Chloro	Epoxy resins, polyurethance, themoplastics

סילאנים

Figure 9. Effect of silane coupling agents on the strength of glass-reinforced epoxy.



סילאנים

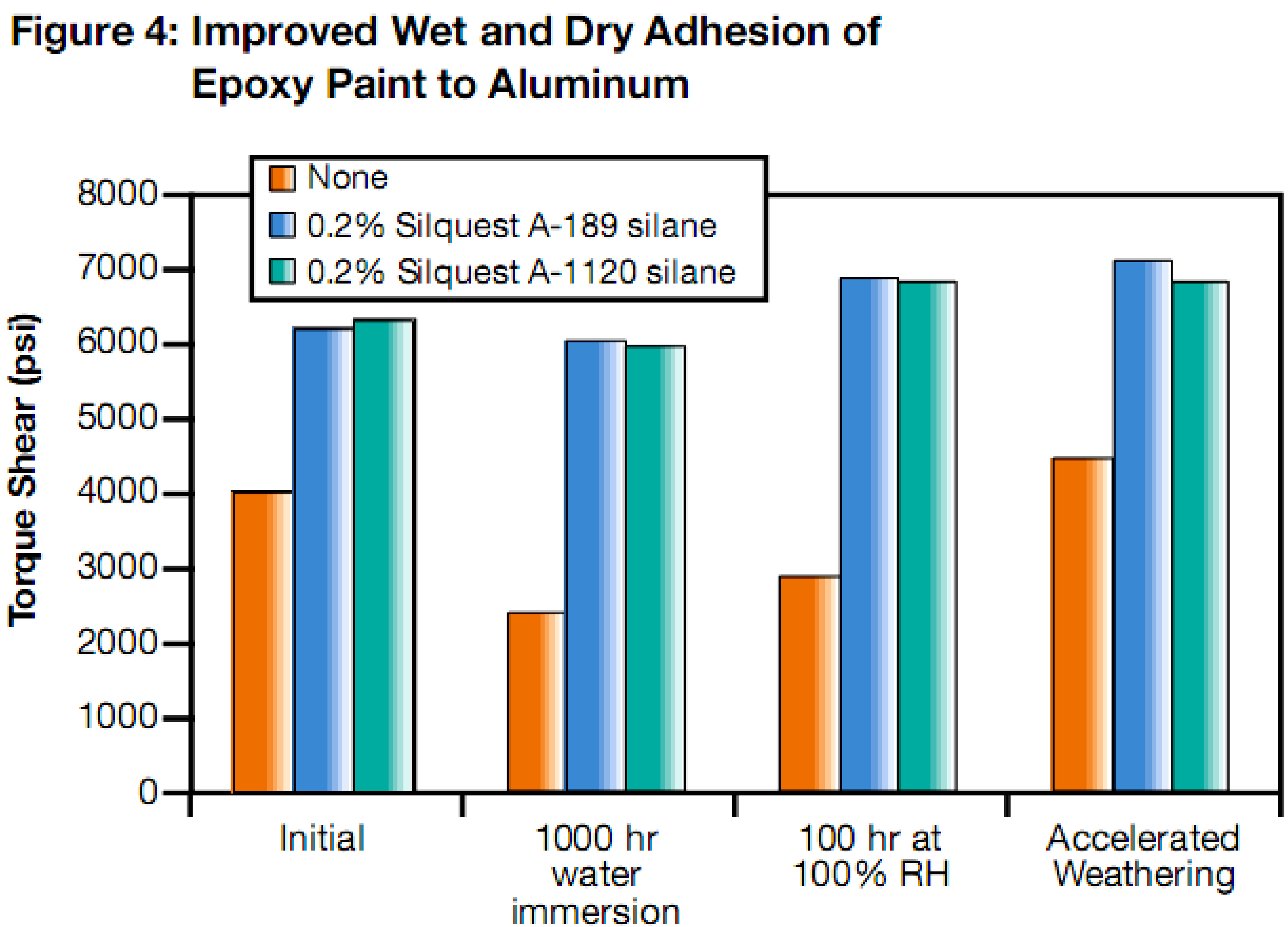


Figure 4: Improved Wet and Dry Adhesion of
Epoxy Paint to Aluminum
None
0.2% Silquest A-189 silane
0.2% Silquest A-1120 silane
Torque Shear (psi)
8000
7000
6000
5000
4000
3000
2000
1000
0
Initial
1000 hr water immersion
100 hr at 100% RH
Accelerated Weathering

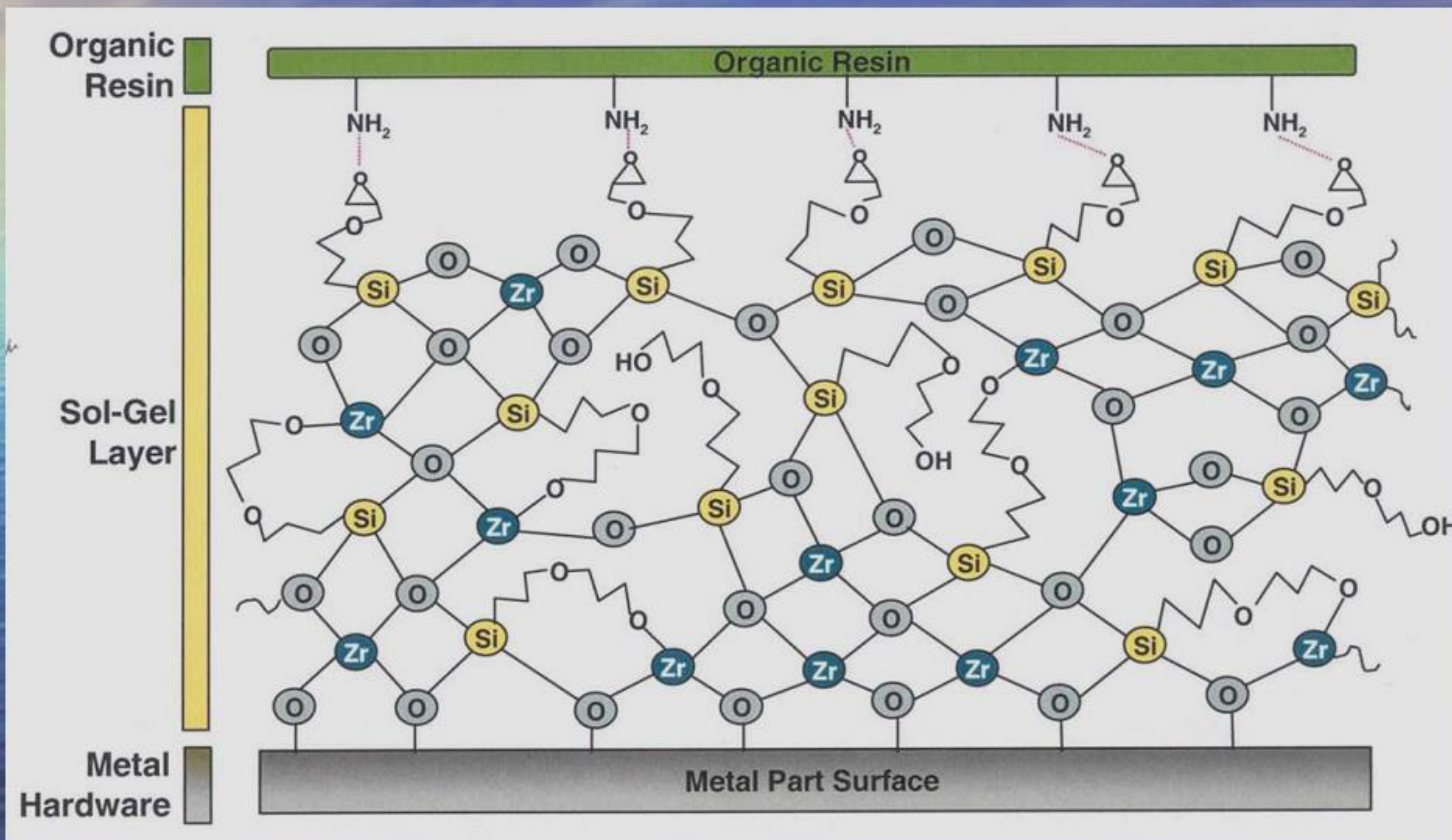
הרכב טיפוסי של פריימר

Table 1: Typical Silane Primer Recipe

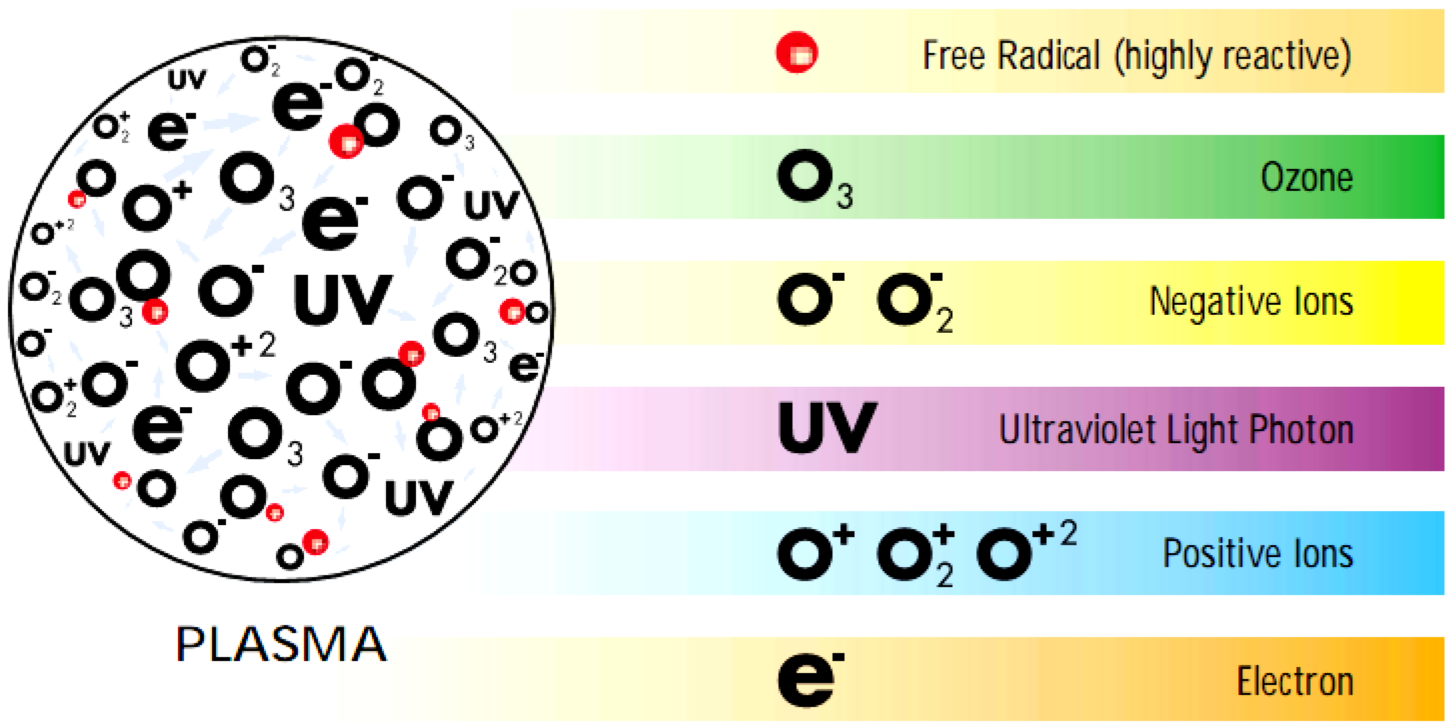
Parts by Weight	Ingredient
5	Organofunctional silane
40	SDA - alcohol
5	Distilled water
40	Xylene
5	n-butanol
4	2-butoxyethanol

Product formulations are included as illustrative examples only. Momentive makes no representation or warranty of any kind with respect to any such formulations, including, without limitation, concerning the efficacy or safety of any product manufactured using such formulations.

Sol- Gel Interphase



פלסמה



This illustration summarizes the active species that are present in an oxygen plasma.

פלסמה

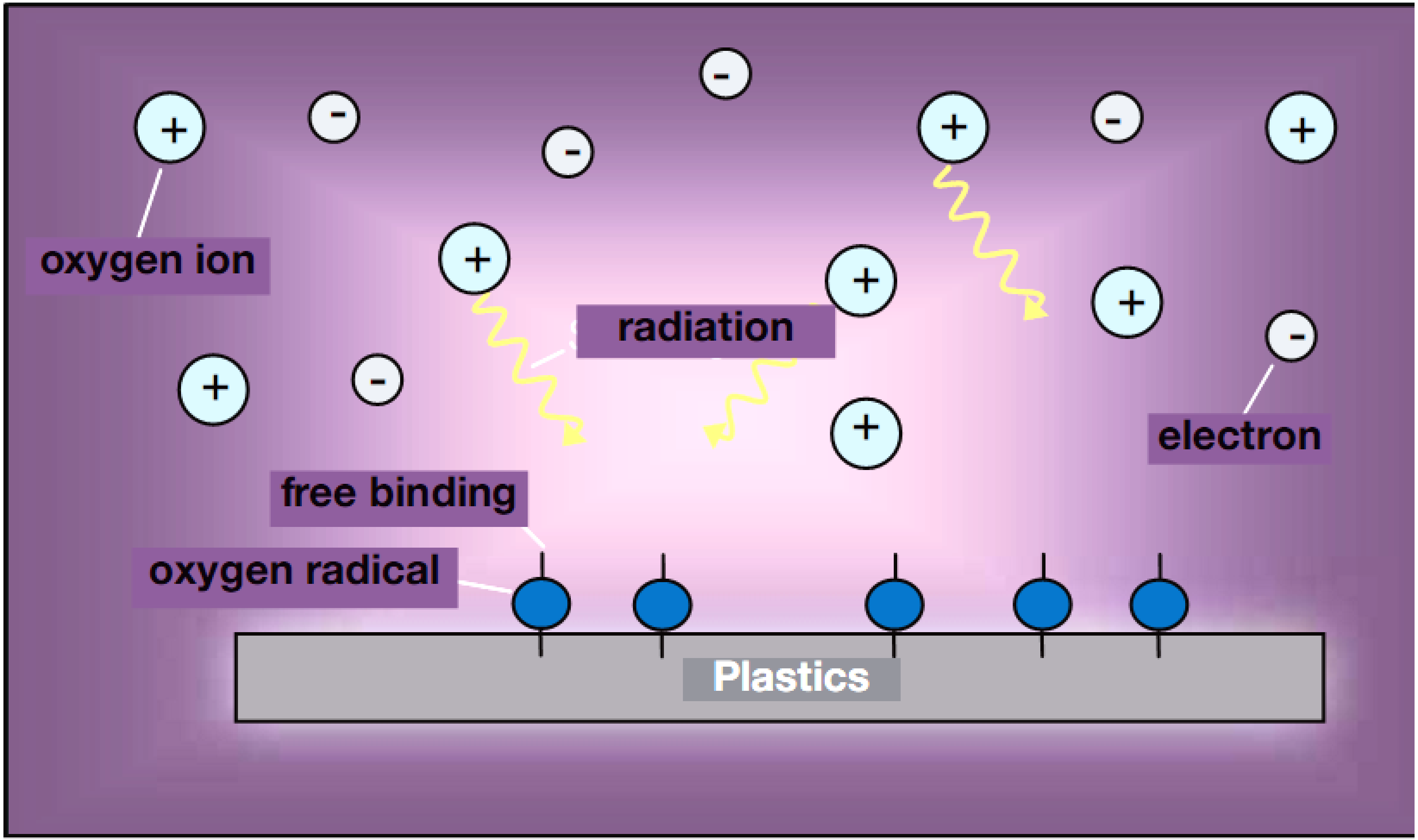


fig. 19: effects on plasma process

פלסמה

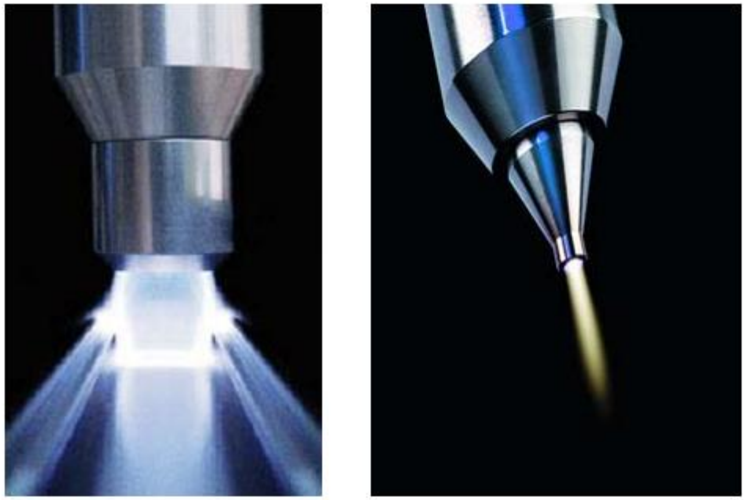
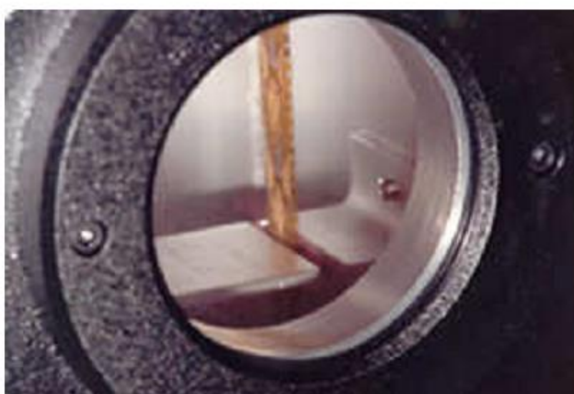


Figure 2 The electrically neutral Openair plasma beam allows microscopically fine cleaning, high activation and paper-thin coating of surfaces

Photo: Plasmatreat



Treatment Chamber Window.

Plasma Treatment in Action.

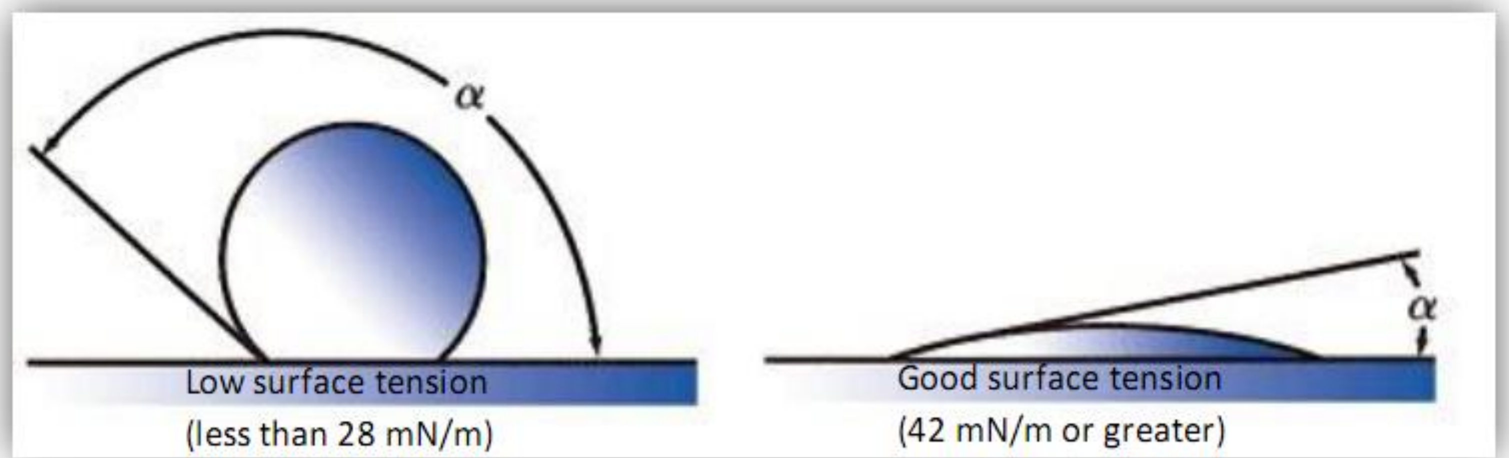


Figure 4 - Surface Tension for Adhesion (5)

Figure 8 - Air Plasma Treatment Applications (13)

Plasma assisted surface modification

Advantages

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

Why Atmospheric plasma technology ?

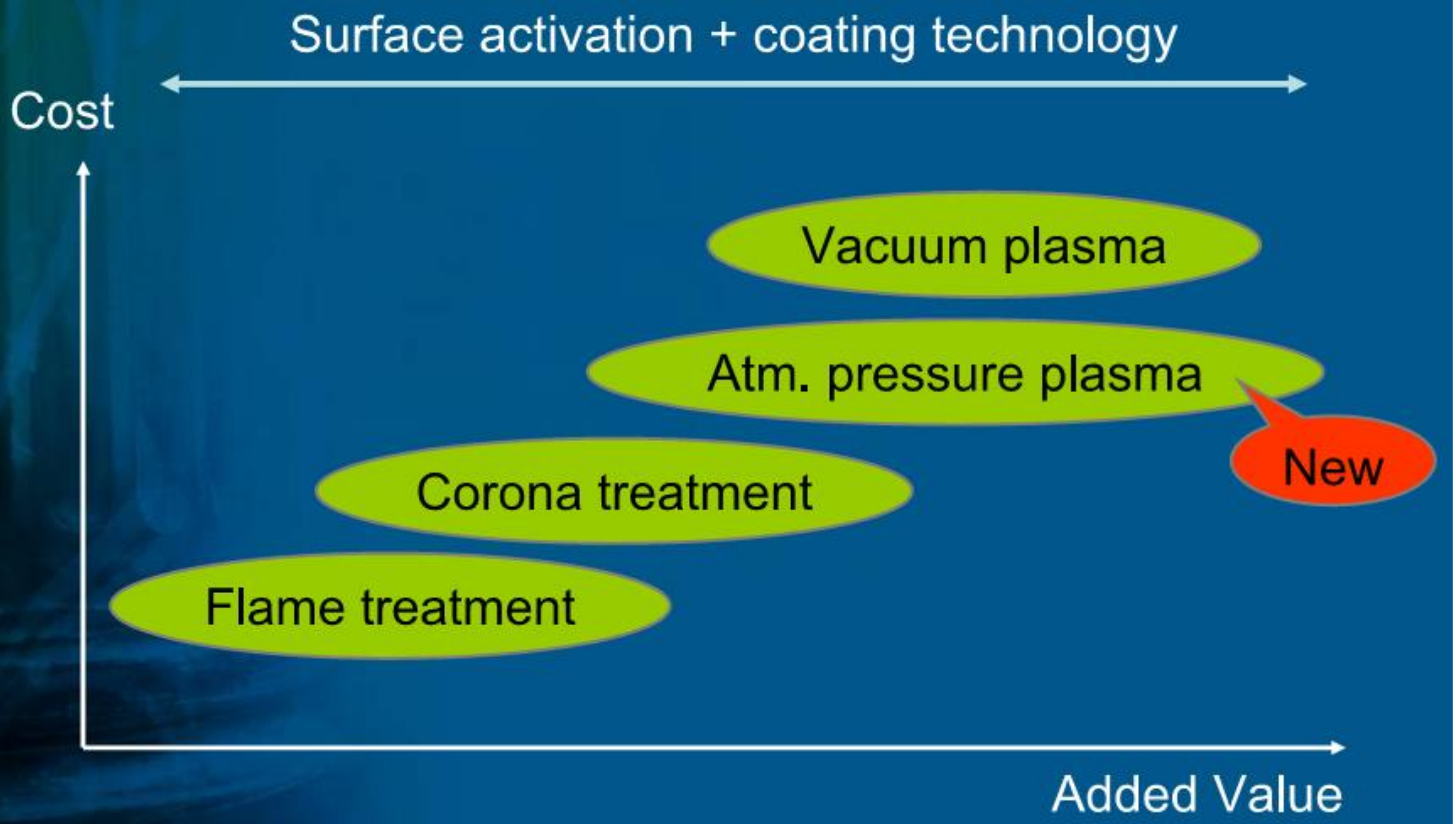


fig. 16: helium plasma

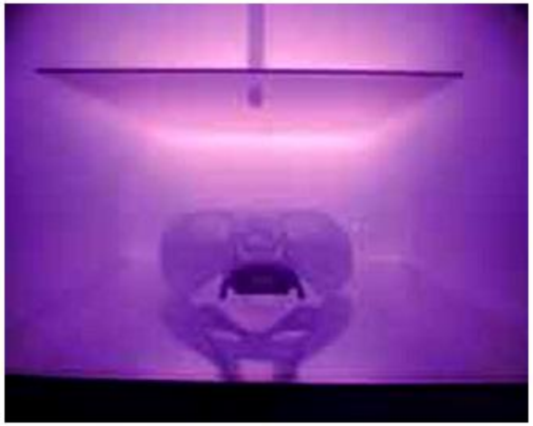


fig. 17: oxygen plasma, high pressure

fig. 18 : oxygen plasma, low pressure

פלסמה

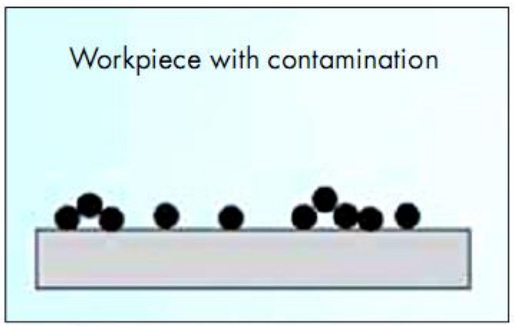


fig. 20: Before plasma treatment

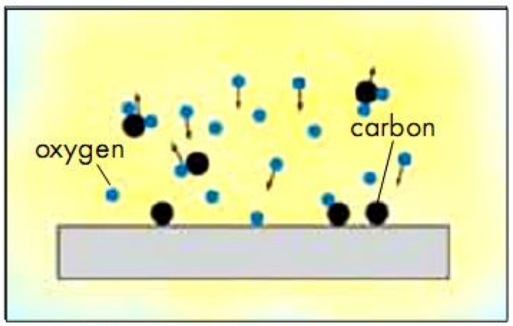


fig. 21: plasma treatment

fig. 22: After plasma treatment

פלסמה

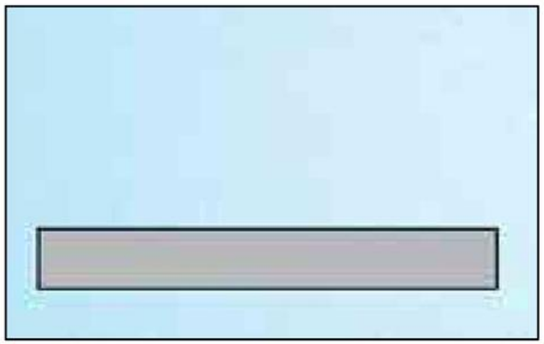


fig. 45: Before plasma treatment

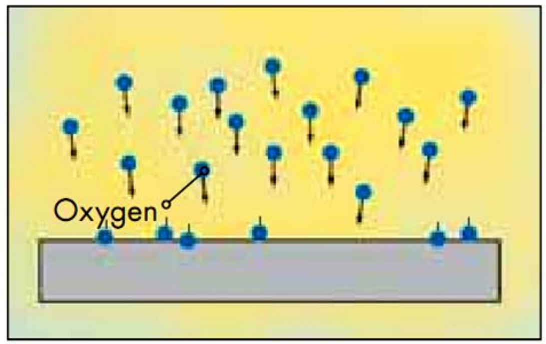


fig. 46: plasma treatment

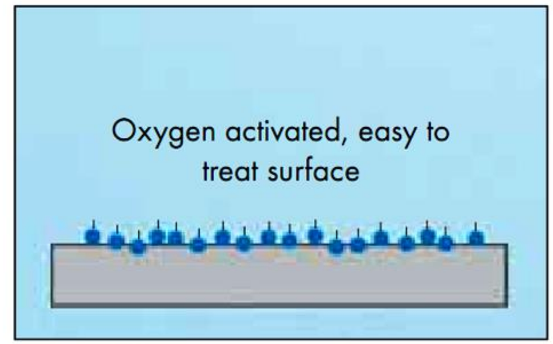


fig. 47: After plasma treatment

פלסמה

Low-pressure plasma also enables coating of components (fig. 51-53).

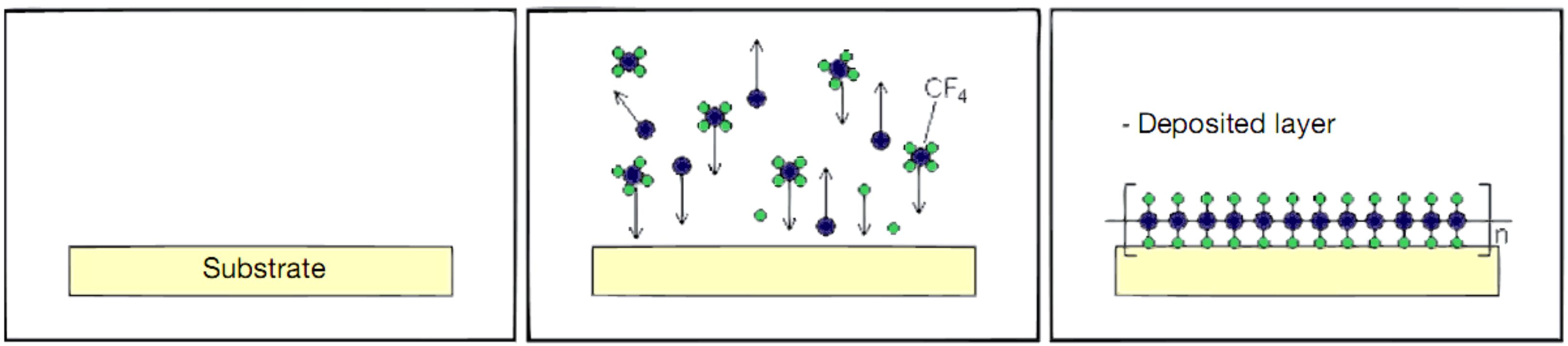
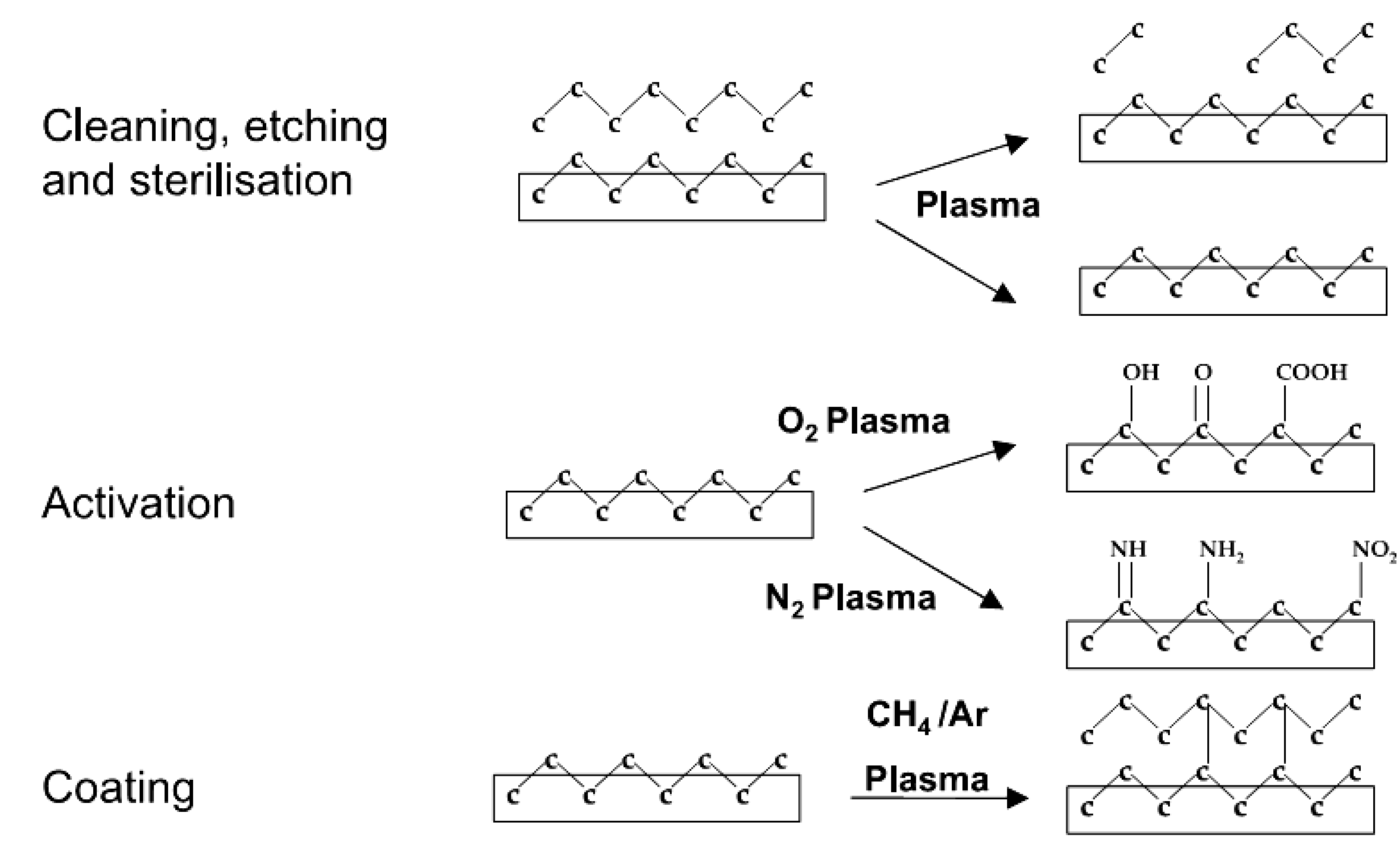


fig. 51: before plasma treatment fig. 52: plasma treatment fig. 53: after plasma treatment

Plasma assisted surface modification



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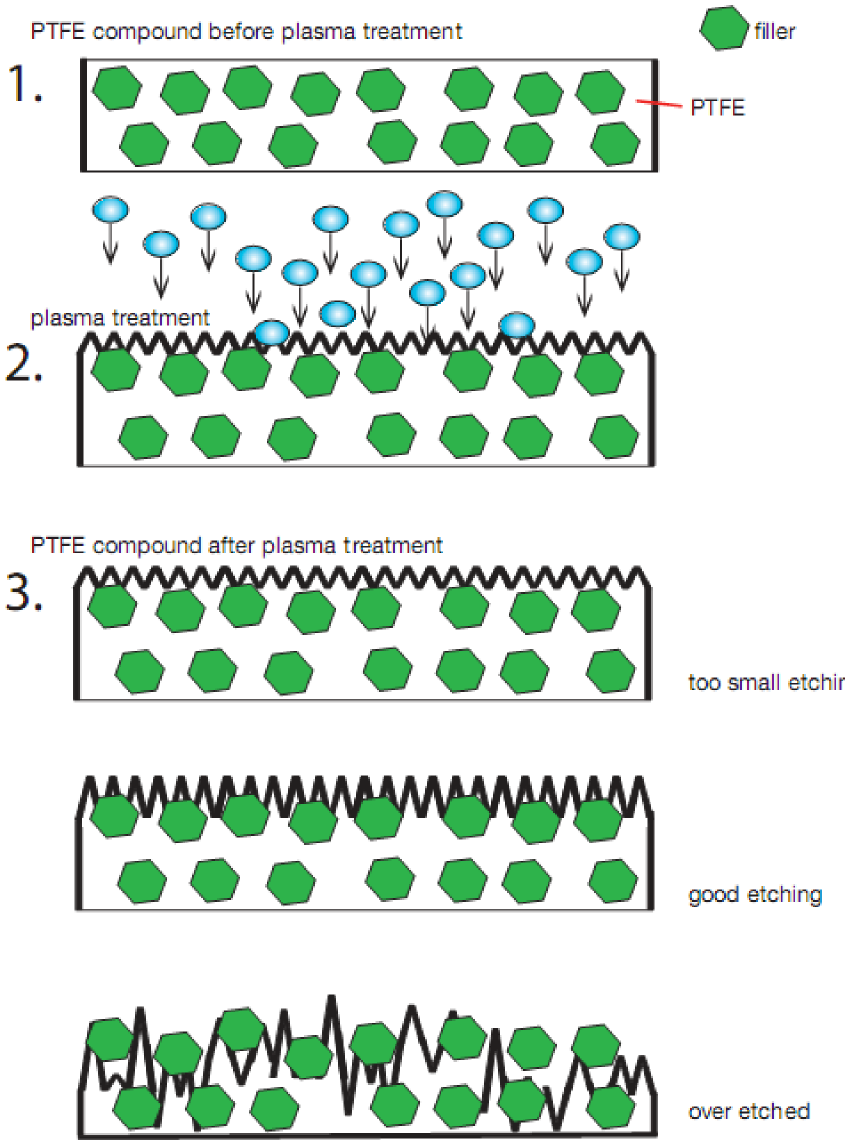

fig. 71: plasma etching of PTFE compounds

פלסמה

B. Reduction of Oxides:

- Metal oxide **chemically** reacts with the process gas (fig. 23-25). Pure hydrogen or a mixture of argon and nitrogen is used as a process gas.

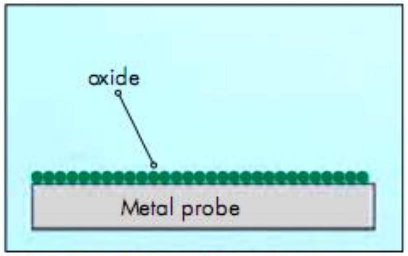

fig. 23: Before plasma treatment

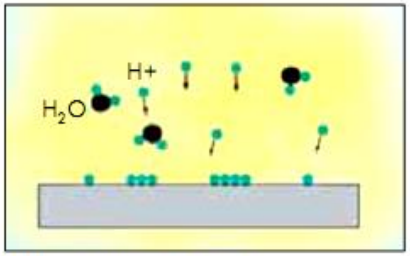

fig. 24: plasma treatment

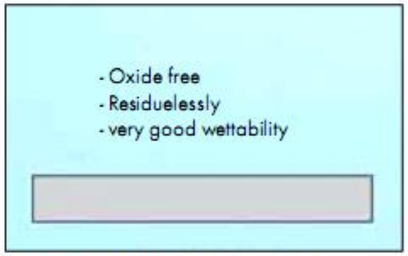

fig. 25: After plasma treatment

It is also possible to execute processes in **two stages**. For example treated parts are first oxidised with oxygen for 5 min (fig. 20-22) then they get reduced by argon-hydrogen (e.g. mixture of 90% argon and 10% hydrogen) (fig. 23-25).

fig. 26, 27, 28 : Examples for cleaning application of metals

פלסמה

Examples of a variety of applications of plasma activation and plastic surface areas:

fig. 29: contact lens

fig. 30: catheter

fig. 31: telephone receiver

fig. 32: prosthesis

fig. 33: automotive components

פלסמה

Example of photos (taken under the microscope)

fig. 37: untreated surface

fig. 38: activated surface

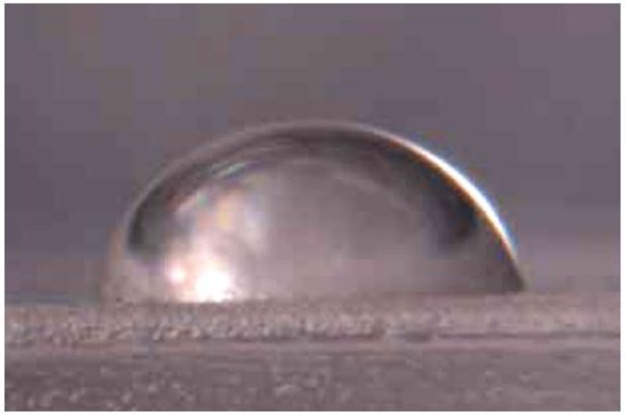

fig. 39: untreated surface

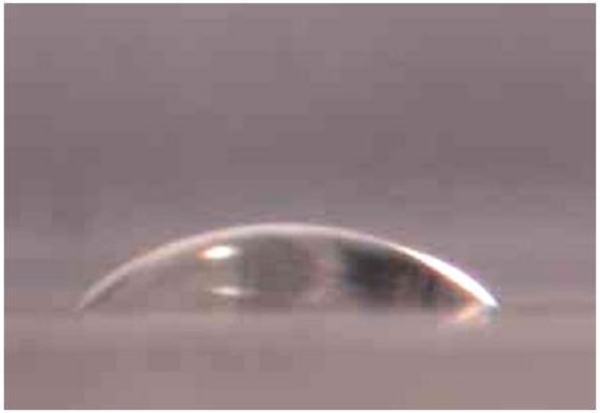

fig. 40: activated surface

פלסמה

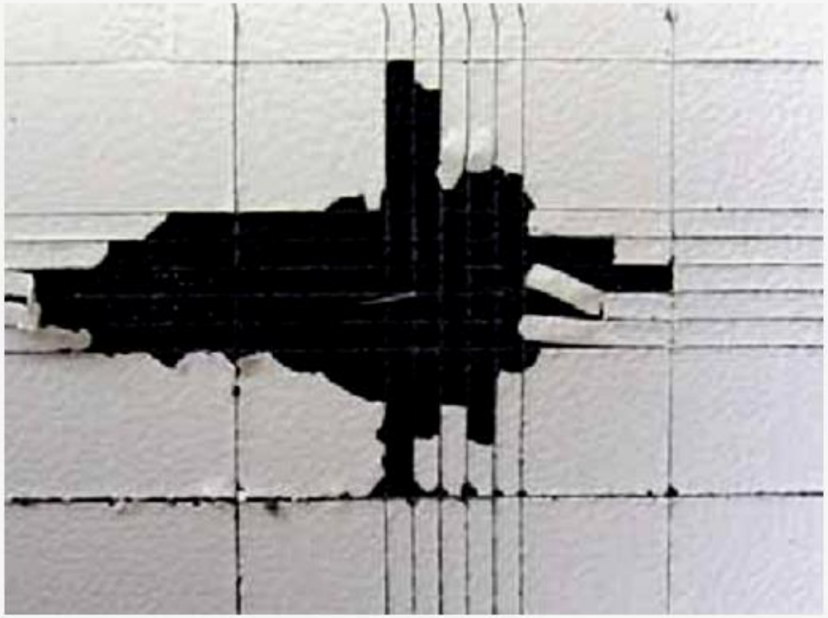

fig. 43: Grid-cut test, untreated

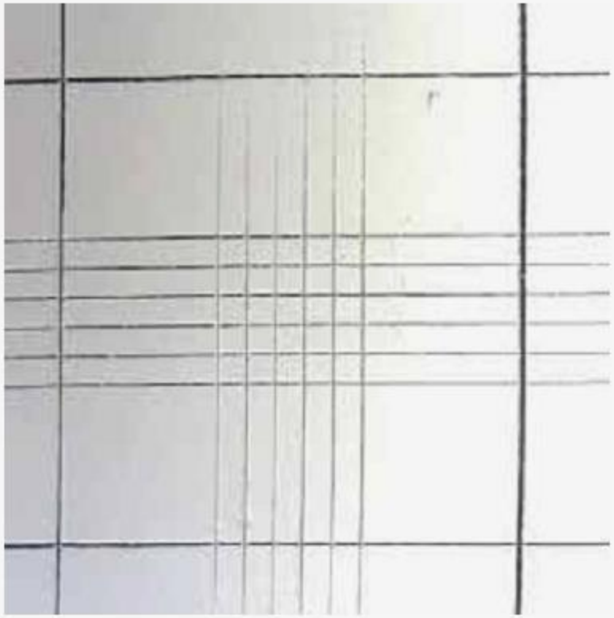

fig. 44: grid-cut test, treated

פלסמה

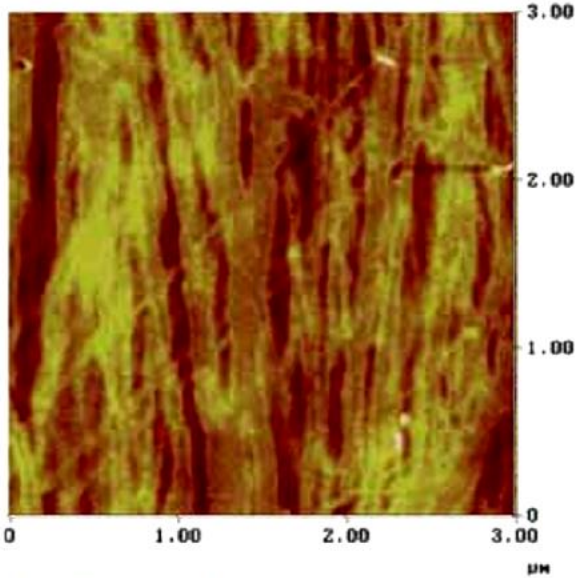

fig. 51: AFM picture of a untreated
PC surface

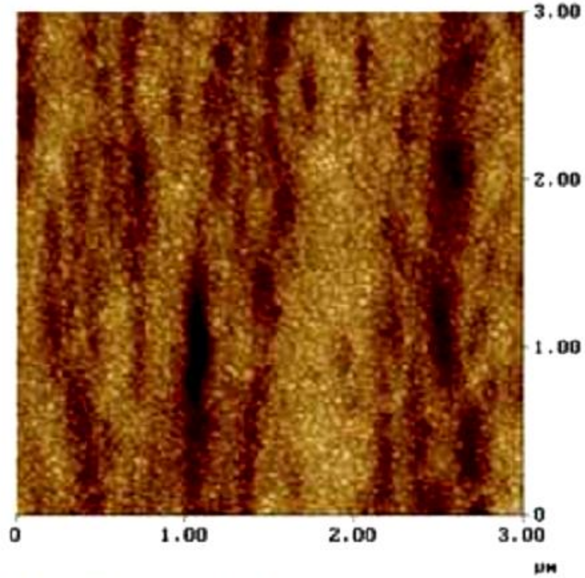

fig. 52: AFM picture of a O_2-plasma treated
PC surface

Pictures with kindly permission of Dr. Ing. Andreas Hegenbarth, IKV Aachen

פלסמה

Process Applications for Plasma Surface Enhancements

Plasma Source Gas	Surface Modification Processes	Advanced Technology Application
Argon (Ar)	Contamination Removal–Ablation	Wirebond Die Attach
	Cross Linking	Substrate Polymer–Metal Adhesion
Oxygen (O_2)	Contamination Removal–Chemical Oxidation Process (Organic Removal) Surface Activation Etch	Wirebond Die Attach Mold and Encapsulant Adhesion Photoresist Removal
Nitrogen (N_2)	Surface Activation	Mold and Encapsulant Adhesion
Hydrogen (H_2)	Contamination Removal–Chemical Reduction Process (Metal Oxide Removal)	Wirebond Eutectic Die Attach
Carbon Tetrafluoride (CF_4) and Oxygen (O_2) or Sulfur Hexafluoride (SF_6) and Oxygen (O_2)	Etch	Polymer Etch–Fiber Stripping Photoresist Removal Thin Film Etch–Oxides, Nitrides

Hydrocarbons	Before	After
Polypropylene	87°	22°
Polyethylene	87°	22°
Polyamide (nylon)	73°	15°
Polyimide	79°	10°
Polycarbonate	75°	33°

Table 1 - Typical Wetting Angles Before and After Oxygen Plasma Surface Treatment (4)

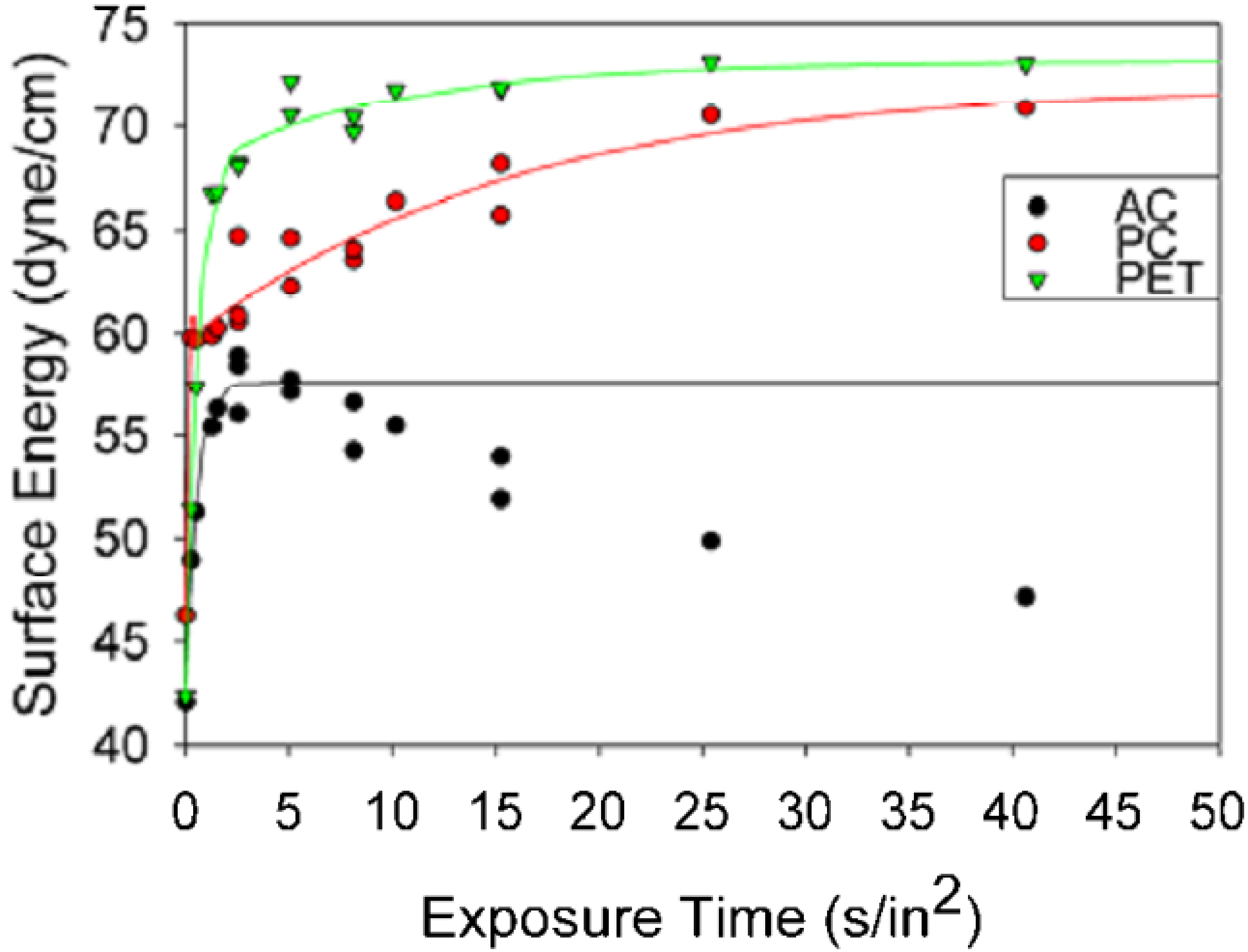

Figure 2. The effect of the oxygen-helium plasma on the surface energy of the polymers.

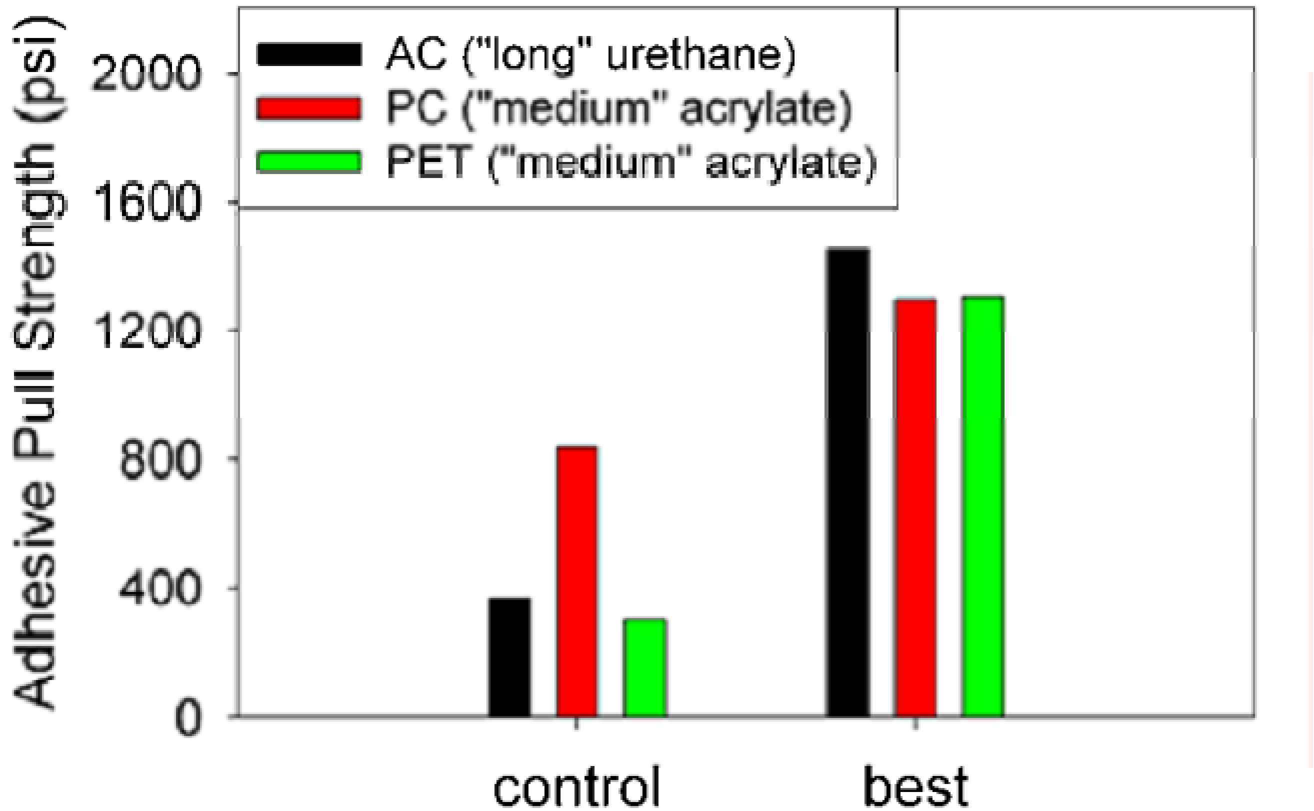

Figure 4. Adhesion pull test data for AC, PC and PET with the best combination of adhesive and plasma treatment.

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