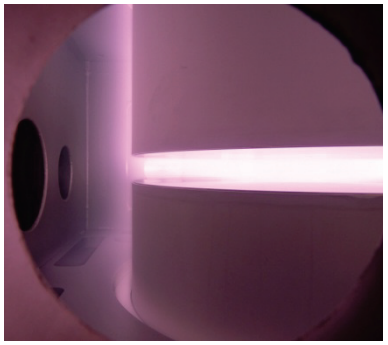
RUHR-UNIVERSITÄT BOCHUM

ACCT
Applied Competence Cluster
Plasma Technology

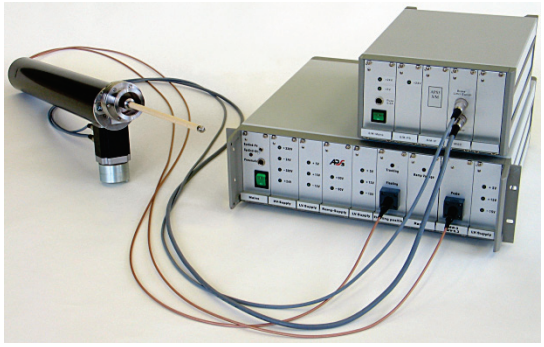
RUB

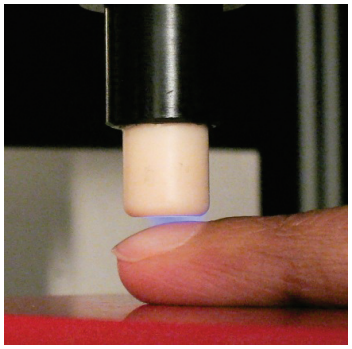
Plasma Surface Treatment of Polymers – Applications from Production to Medical Technology

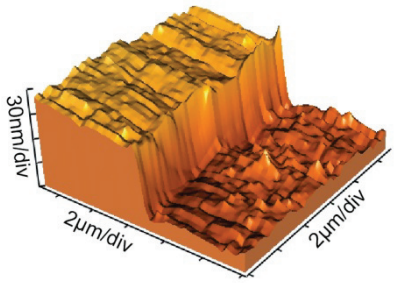


Innovations for Industry @ MicroNanoTec

4. April 2011 HMI 2011







Polymers – An all-purpose material

- Widespread use of polymers
  - Packaging, Consumer, Medical, …
- Expected market volume till 2015 for medical polymers alone 2.1 billion USD!
- Typical polymer challenges
  - Hydrophobicity
  - Thermolability
  - Insufficient barrier properties
    - Recyclates with trace impurities compromising package content
  - Sterility

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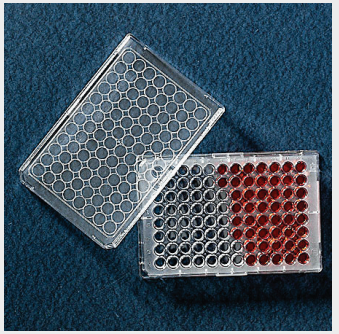

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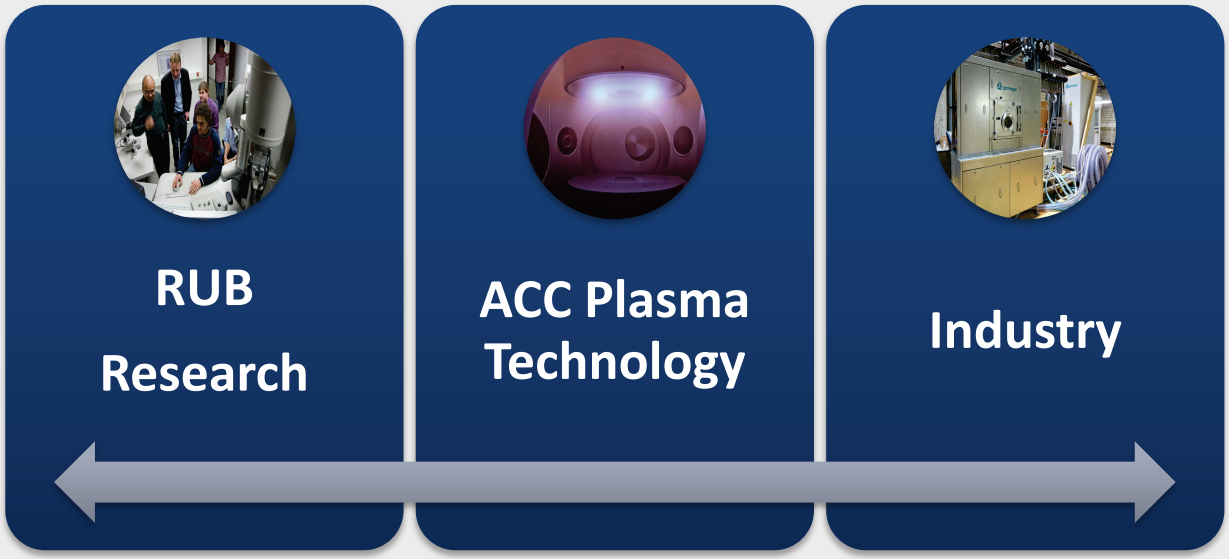
Outline

- Polymers – an all-purpose material
- Applied Competence Cluster @ RUB: Research goes commercial
- Pre-Treatment of Polymers
- Permeation / Diffusion barriers for Polymers
- Plasma Sterilization
- Polymer Surface Functionalization
- Outlook – Future Research Focus

Applied Competence Cluster – Research goes commercial

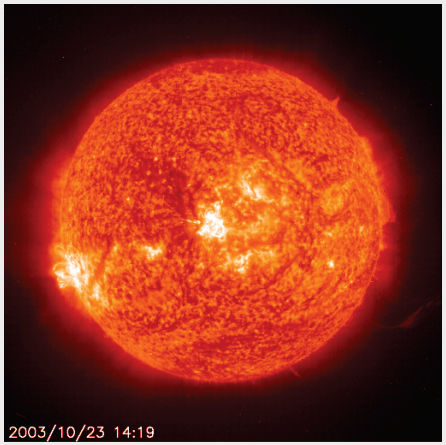


- Concentrated research in RUB “Research Departments”
- Largest group of plasma technology scientists in Europe
- Comprises institutes from chemistry, biology, materials sciences and electrical engineering

Applied Competence Cluster – Research goes commercial

- Our core expertise
  - Metal, ceramic and hard diamond-like coatings
  - Agent barrier enhancement
  - Automotive Lighting
  - Medical Technology
    - Decontamination & Sterilisation
    - Pre-treatment of Polymers
    - Diffusion barriers
    - Adhesion-promoting layers

Plasma ?



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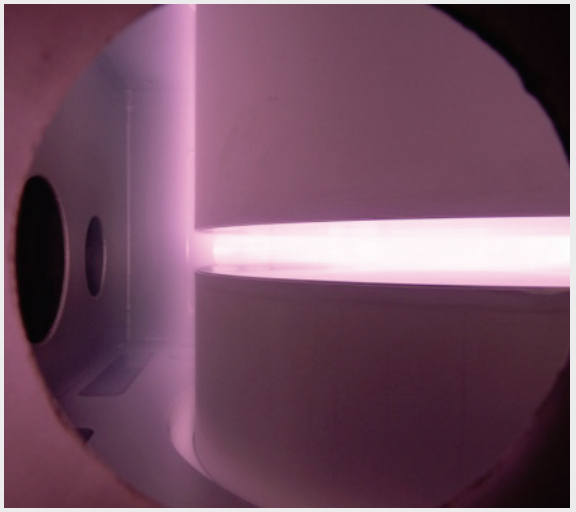
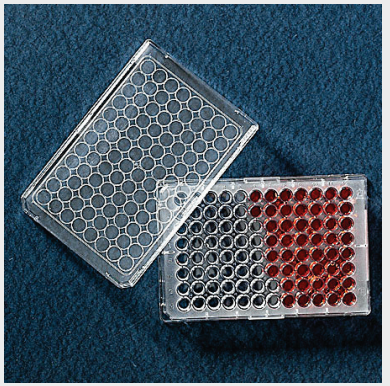


Surface Activation of Polymers



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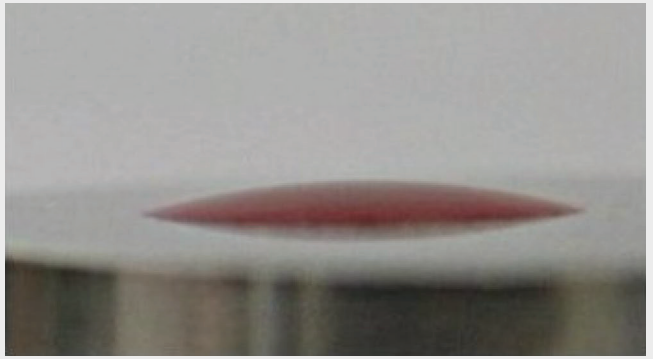
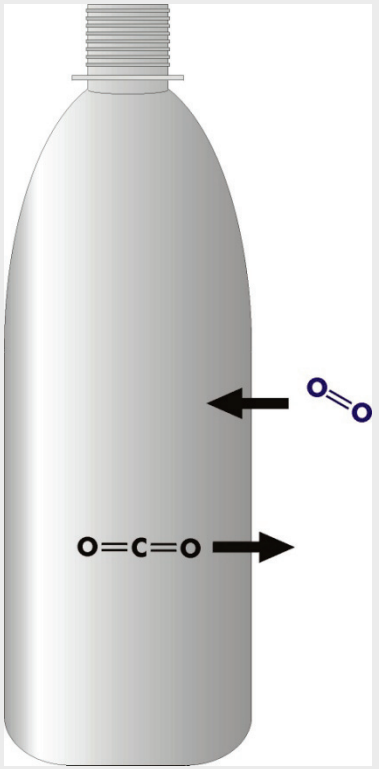
- Cleaning of organic remnants
- Tuning of surface wettability
  - (Super-)hydrophobic / – hydrophilic
- Creation of „dangling bonds“ → open atomic sites where new substance can easily attach
- Pre-process step for adhesion promotion



Permeation barrier coatings – Purpose

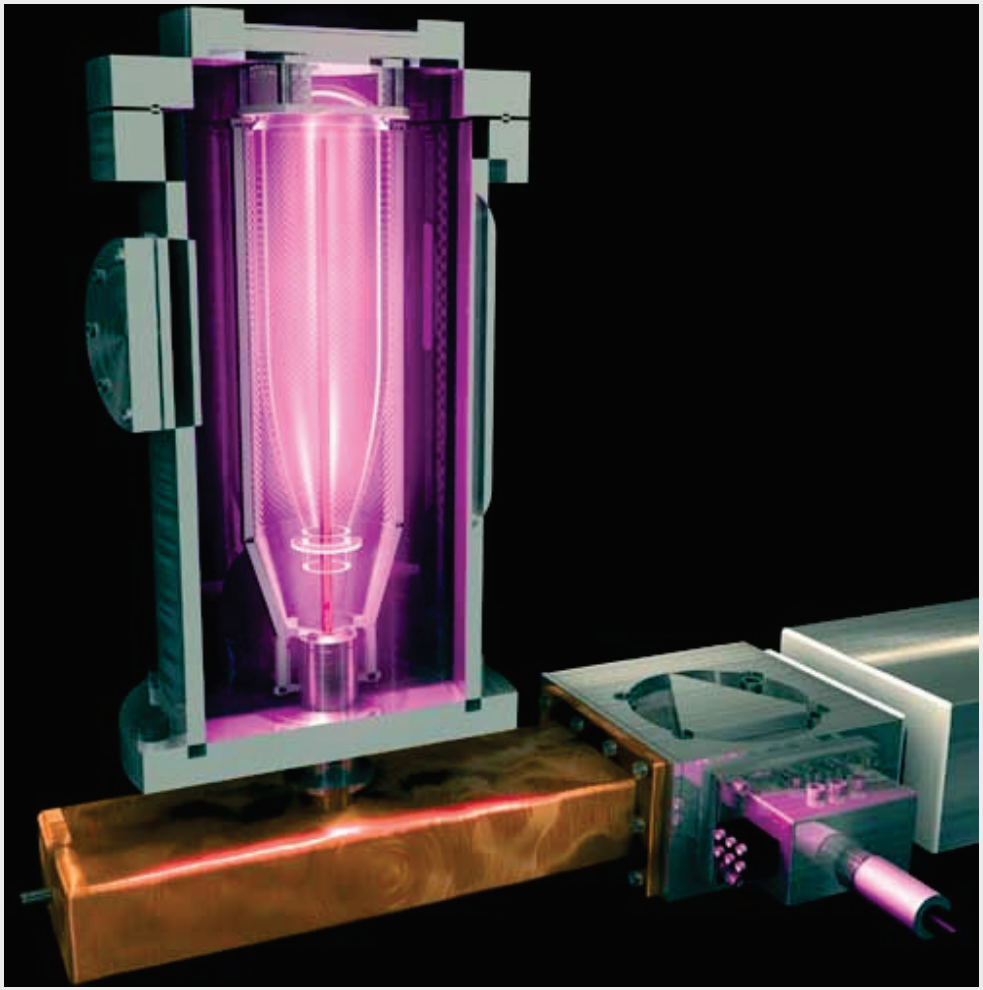
- Example: PET Bottles are gas permeable
  - Food degradation oxygen entering bottle
  - Carbon dioxide escapes



- Example: Polymer recyclates
  - Impurities in/on polymers enter recycling chain
  - Packaging contaminates contents!
    - Toxic, cancerogenic, mutagenic, ...

- Example: Metallisation on polymer (e. g. circuitry)
  - Prevent long term diffusion of metal into polymer!

Permeation barrier coatings – Application

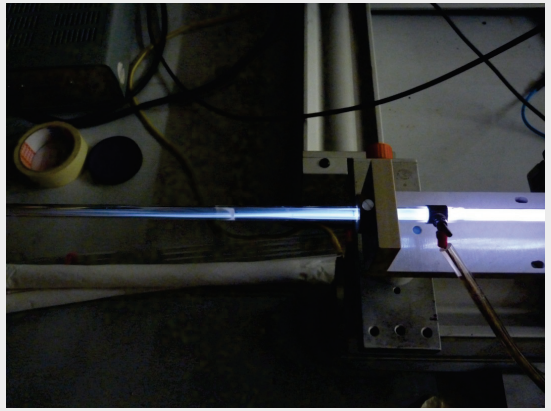


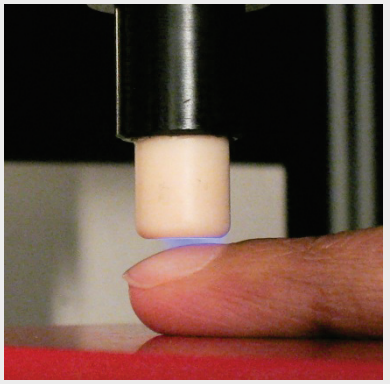
- Example: PET bottle
- Low pressure plasma
- PE-CVD process
  - Non-thermal process!
- Barrier coating
  - Si_xO_y
  - Dense carbon layer
- Coating thickness <100 nm

Permeation barrier coatings – Future Trends

- Low pressure plasmas
  - Large invest in UHV chamber/pumps etc.

- Atmospheric Pressure Plasmas
  - Easily scalable
  - Comparable coatings quality @ significantly reduced costs
  - Non-thermal activated process!
  - Even diamond-like carbon (DLC) coatings realizible @ room temperature!





Plasma Sterilisation

- Strong increase in nosocomial infections require alternative sterilization techniques for polymers
- Gentle and residue-free sterilization method
- Sterilization can be achieved in 10s
- Capable of prion deactivation!
- Applicable in low and atmospheric pressure

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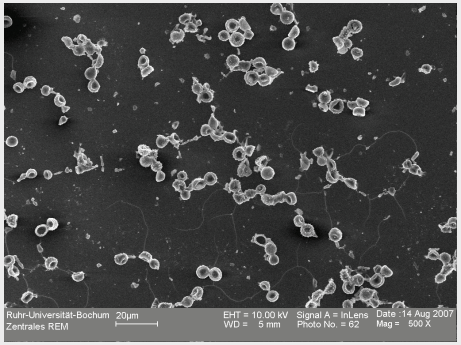
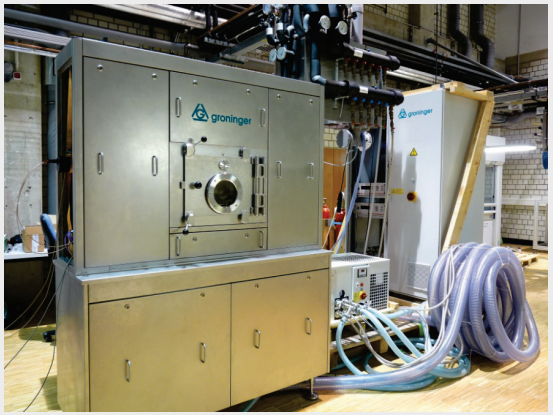


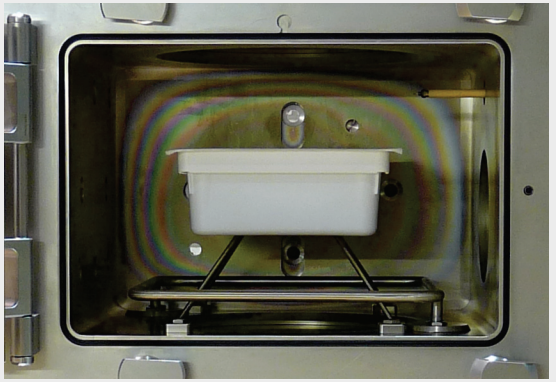
Sterilisation of medical mass goods

- Commercial cooperation lead to first plasma sterilizer

- Fully integrated in-line transfer-lock sterilizer for aseptic syringes filling production
  - Installed at line with major pharmaceutical company
  - FDA & EMEA validation in progress

- A success story from Science2Business
  - Further information on Friday 08.04.2011, 09:30 - 09:45, Hall 2, Booth D12 TechTransfer Session





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Medical applications – Future developments

- Atmospheric Plasmas will play a key role in the future for surface and tissue treatment
  - Cost-efficient and easily scalable

- Plasma Medicine – A new working field
  - Wound treatment
  - New developments in chemical engineering with pre-treated plasma surfaces
  - Dental applications
    - Cleaning & sealing of fissures

Functionalization of Polymer Surfaces

- Deposition of functional carbon-groups on well-plates as marker attachments / Bio-Indicators

- Metallization for electronics and rf circuitry
  - Detection in medical applications

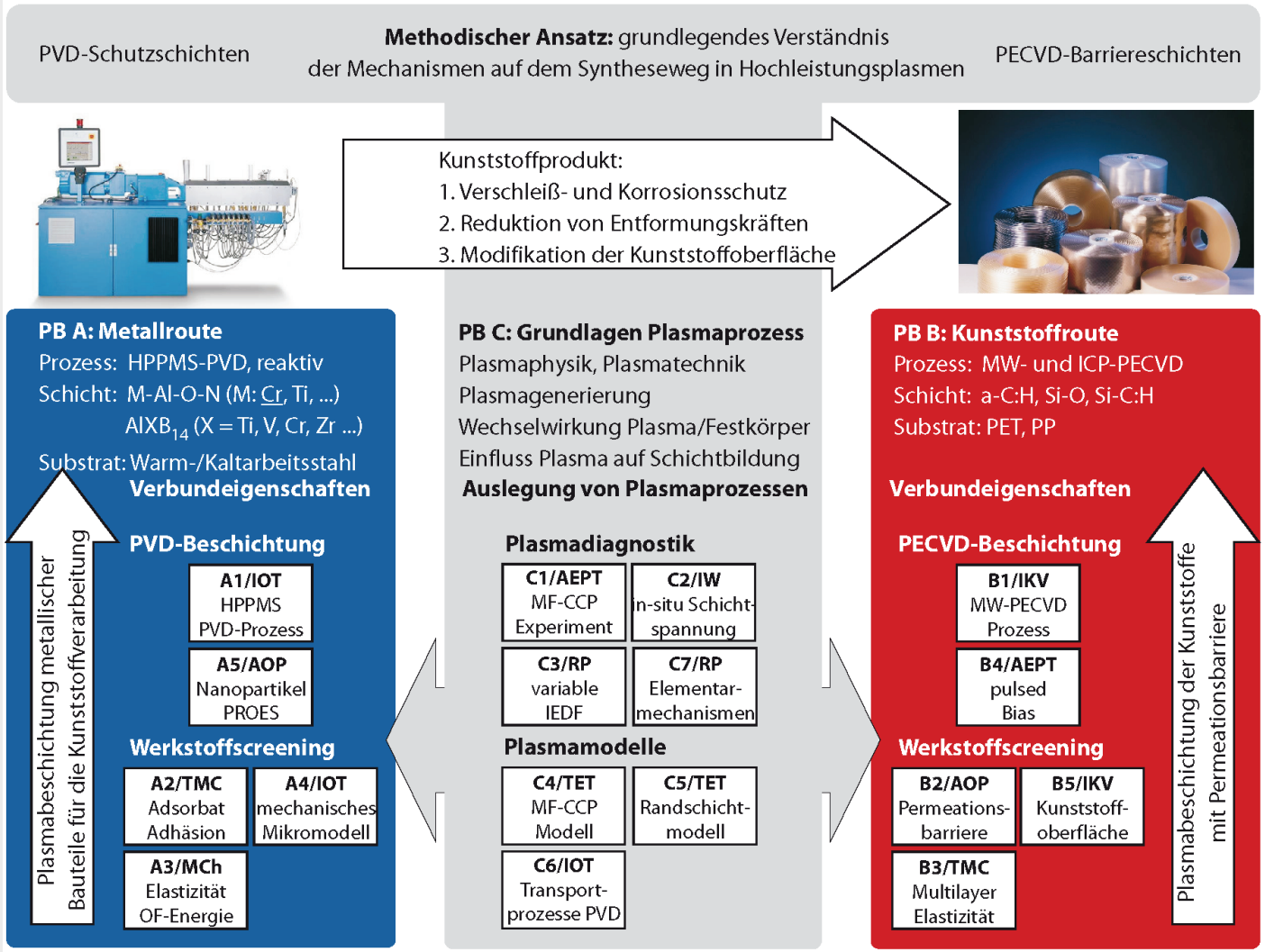
- Wear resistant coatings for polymer-polymer abrasion
  - E. g. dialysis pumps

- Strain compensated coatings for
  - Permeation barriers
  - Wear-resistant hard DLC coatings

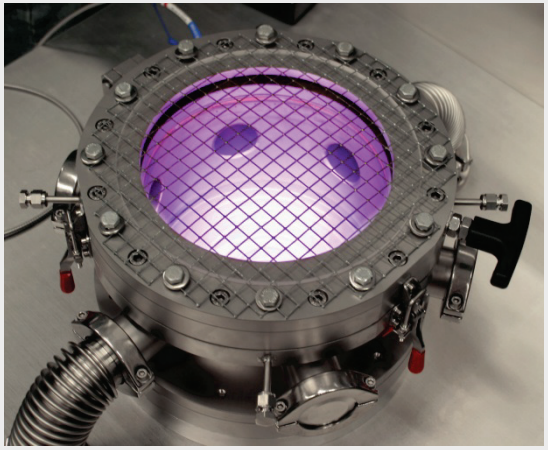
Future Research on Polymer Surfaces

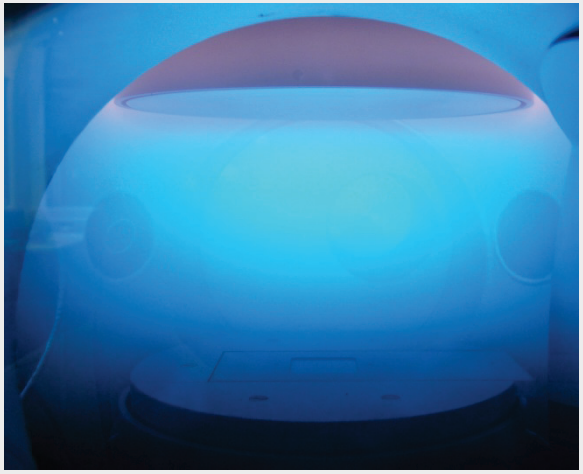
SFB-TR 87

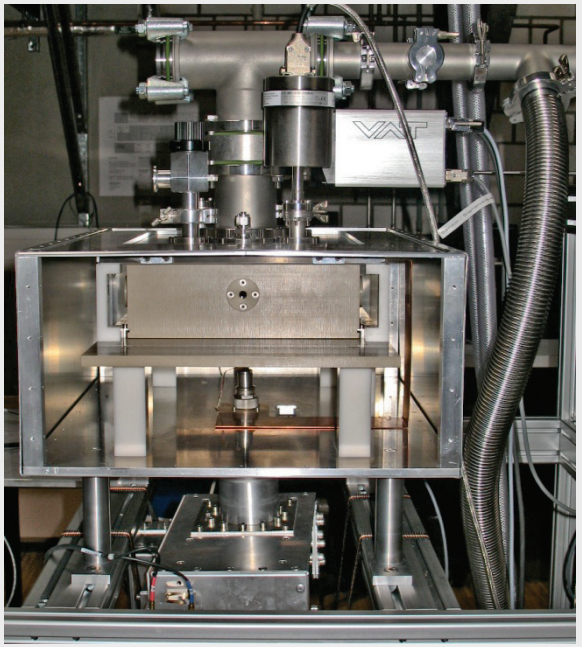
- Permeation barriers in catheters
- Inner treatment of long flexible tubing using microplasmas
- Enhancement of coating elasticity on polymers

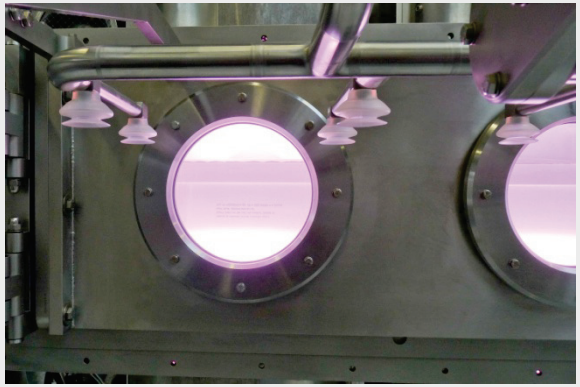


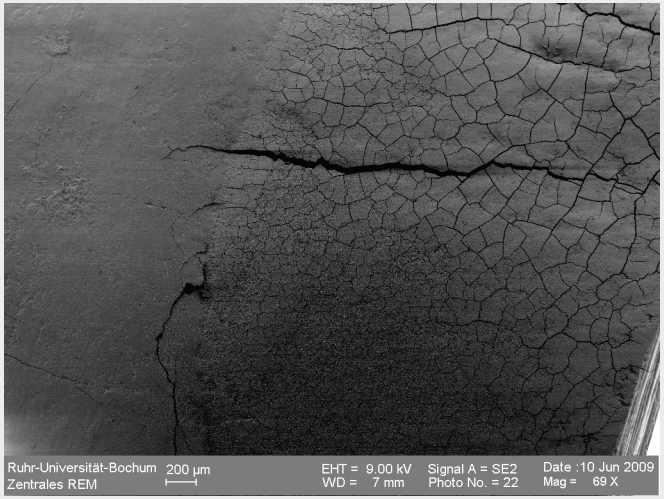
Thank you! Questions?











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