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1 *Excimer plant in the technical laboratory of PLATO at Fraunhofer IFAM.*
2 *Xenon excimer lamps (Xeradex® emitter, OSRAM GmbH) in the excimer plant.*

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM
– Adhesive Bonding Technology and Surfaces –
Wiener Strasse 12
28359 Bremen | Germany

Institute director
Prof. Dr. Bernd Mayer

Contact

Plasma Technology and Surfaces – PLATO –
Dr. Ralph Wilken
Phone +49 421 2246-448

VUV technology
Dr. Christopher Dölle
Phone +49 421 2246-621

vuv-tec@ifam.fraunhofer.de

www.ifam.fraunhofer.de

COATING AND ACTIVATION OF SURFACES USING VUV TECHNOLOGY

Functional coatings in industry

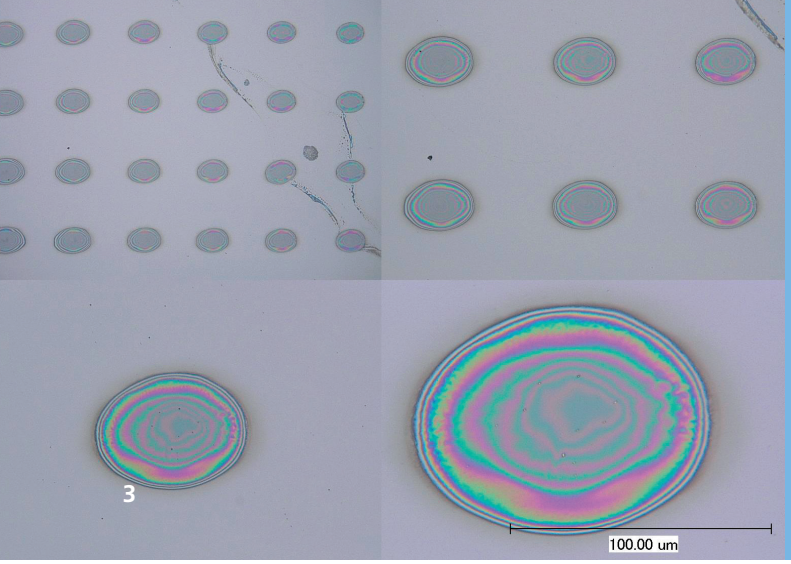
There is a high demand for special functional coatings for components and products – in a range of industries including the car manufacturing industry, the plastics industry, and the biotechnology sector. Customized pre-treatment and tailored coatings allow the quality of products to be increased and their uses diversified.

VUV technology of the Fraunhofer IFAM

The experts of Plasma Technology and Surfaces PLATO at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM have developed a pilot plant scale VUV unit (VUV = vacuum ultraviolet radiation) to expand the existing pre-treatment and coating technologies (Fig. 1).

The core part of the unit contains xenon (Xe_2*) excimer lamps which emit incoherent light at a wavelength of 172 nanometers (Fig. 2). Compared to conventional UV radiation the VUV radiation has a higher photon energy. This enables the radiation to break different types of molecular bonds and thus to photochemically modify the properties of surfaces. The radiation field is very homogeneous. There is normally no heating of the irradiated components.

Up to 40 percent of the electrical energy that is consumed is available as VUV radiation. Due to this high degree of conversion there is in some cases no need for additional lamp cooling. The comparatively low power usage means that the system is resource-friendly.



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Almost 100 percent of the emitted radiation is available to users in the VUV spectral region at 172 nanometers, with a bandwidth of 14 nanometers.

An alternative to the xenon excimer lamp is the low pressure mercury (Hg) lamp. Its VUV emission line is at 185 nanometers. Although the conversion efficiency of this light source is lower than an excimer lamp, this system is more favorable in cost. The PLATO experts can advise you about the choice of radiation source for your particular application.

The required process atmosphere depends on the requirements of the application. The irradiation is usually carried out in an air or nitrogen atmosphere. Both, continuous and batch processes are possible.

Activation and functionalization of surfaces

Surfaces, and in particular polymer surfaces, can be activated by VUV systems without damaging the bulk material. It is also possible to functionalize the surface by adjusting its chemical composition, so allowing further coatings to be applied or the attachment of specific molecules. These surface modifications can readily be used for localized functionalization (Fig. 3).

The VUV systems developed by Fraunhofer IFAM thus represent a technically simple, resource-friendly, and favorable-cost alternative to conventional pre-treatment systems.

Applications

Activation and functionalization using VUV technology prior to:

- Adhesive bonding
- Painting/lacquering
- Printing
- Selective coupling of biomolecules
- Grafting

Functional coatings

A functional coating is applied in two steps: First a liquid precursor is applied in a layer thickness ranging from a few nanometers to several microns. Secondly the liquid precursor film is converted to a solid film by VUV radiation.

The energy of the photons suffices to initiate bond breaking in the liquid. The resulting reactive molecule fragments react with each other and form a 3D crosslinked layer. The functionality is customized by tailoring the degree of crosslinking and by careful choice of the precursor (Fig. 4).

Applications

- Release layers
- Corrosion protection coatings
- "Easy-to-clean" layers
- "Anti-fingerprint" coatings

Portfolio of the Fraunhofer IFAM

- Technology transfer
- Sample provision
- Development of customized surface technologies
- Concepts for plant design

3 *Localized functional coatings allow a hydrophilic grid to be created on a hydrophobic base surface (applications: anti-icing coatings, microtiter plates, etc.).*

4 *A VUV primer layer gives the desired cohesive fracture in a bonded joint (left); with no coating the result is an adhesive fracture (right).*