Transparent Corrosion Protection for Metals

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Microwave generated plasmas excel in low-pressure applications because of high attainable plasma densities and low ion energies. They are highly compatible to polymer substrates and so are used to develop new functional surfaces, e.g., scratch resistance for automotive applications or coatings for solar cells.

In this paper we present a microwave generated Plasma Chemical Vapour Deposition (PCVD) process for transparent, electrical and gas-diffusion insulating and corrosion protecting coatings on metals (Copper, stainless steel, etc.). This procedure is an environmental friendly and energy saving alternative to lacquering or enamelling.

The principle chemical reaction is given by:

$$(\text{CH}_3)_3\text{Si-O-Si(}\text{CH}_3)_3 (\text{g}) + n \text{O}_2(\text{g}) + \text{plasma energy} \rightarrow 2 \text{SiO}_2 (\text{s}) + y \text{H}_2\text{O}(\text{g}) + z \text{CO}_2(\text{g})$$

The vaporized siloxane (gaseous) reacts with the oxygen (gaseous) under plasma energy to quartz (solid), gaseous water and carbon dioxide (gaseous). The quartz is deposited on the substrate.

Using scalable plasma sources, e.g. an array of Duoplasmalines®, the process is also applicable to large polymer parts like windshields. With such an array of a few lines, a high rate of over 5µm/min on a small scale (15 x 15 cm) and of about 2 µm/min on a large scale (1/2 m²) was already reached for the deposition of SiOx-coatings with a homogeneity smaller than 10% on flat substrates. The deposition-rate from the small scale seems to be also reachable at the large scale by planned equivalent enhancements of the MW-power and the used vacuum-pumps.

The coating-rate is about 10 nm/s. The coating survived several thermal shocks by heating to over 400° C and followed dropping into cold water without any damages like cracks or adhesion-losses. The thermal stability was also measured by heating several coated steel-substrates in an oven for 3h with no change at 450° and very slightly darkening at 600°, without coating damages. The coating is highly transparent and clear between the measured UV-B and NIR wavelength.

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