

Plastics with a **Touch of Glass**

Schott HiCotec adds value to plastic products using PICVD coating technology.

► What do plastic lenses for glasses and PET bottles have in common? Both are made of plastic, light in weight and unbreakable and in many situations are preferred to glass. To obtain maximum benefit for plastics in these applications, however, a number of properties need to be improved. Plastic lenses should be scratch resistant; PET bottles need a better barrier against oxygen and carbon dioxide to preserve the quality of a number of important food and beverage products.

To maximize the benefits without sacrificing any of the fundamental properties, plastics are frequently used in combination with other materials, often another plastic, in blends, multilayer structures or by applying a coating to the plastic surface. Schott Hi-

Cotec, a division of Schott Spezialglas GmbH is a specialist company in the field of coatings initially developed for glass. More recently this same coating technology has been successfully applied to enhance the properties of a number of commercially important plastic materials. The company's program includes the complete development of the required technology – from first sample to industrial-scale production, as well as the design and construction of coating machines.

Worldwide patented process

Schott HiCotec's underlying coating process is the Plasma Impulse Chemical Vapor Deposition (PICVD) technology, which has been patented worldwide. It was developed

by Schott 20 years ago and has been successfully applied to the coating of mass-produced glass components such as cold light reflectors, energy-saving light bulbs and pharmaceutical vials. The new Schott HiCotec division was established to expand the technology into the coating of plastics important in the packaging, optics, telecommunications and automotive industries. In recent months the company has been successful in adapting the original PICVD process to apply glass-like oxide layers of silicon dioxide or titanium dioxide to a number of important plastics – PET, PMMA, PC, PP, HDPE and PLA. A key requirement in the coating of all of these materials, to minimize damage to the surface, is the need to keep the coating temperature as low as possible. This is achieved by the feature of the PICVD process that distinguishes it from other plasma processes – the pulsing of the plasma.

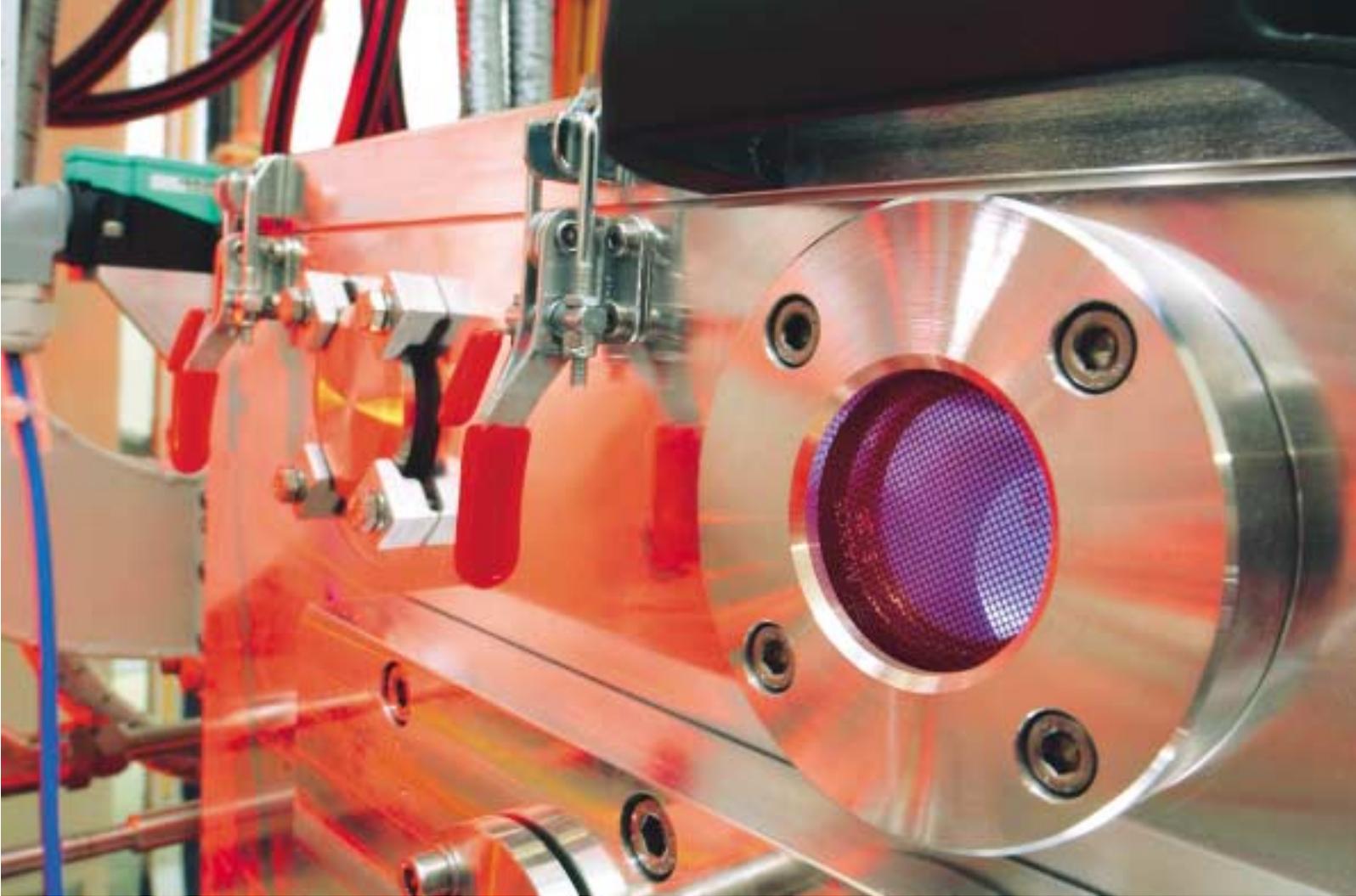
Applying an anti-scratch and anti-reflection coating

In a single process using the PICVD technology, it is possible to apply a multilayer coating to plastic display covers and lenses that make the plastic surfaces scratch resistant. In addition, the anti-reflection coating makes the displays used in mobile phones, measuring instruments or navigation systems easier to read.

Coatings can be designed and developed to meet the customer's requirements. A typical multilayer system applied to a display window consists of an adhesion layer – essential in ensuring that the coating does not detach from the display during testing and in use, an anti-scratch layer and the anti-reflection layer. The anti-scratch layer consists solely of silicon dioxide, a pure form of glass

After application of the multilayer system, mobile phone display covers have a scratch resistance similar to glass. The addition of the anti-reflection coating reduces the reflection from the surface to less than one percent.





and very hard. The anti-reflection layer consists of alternate layers of silicon dioxide and titanium dioxide, the number of layers depending on the application. With this coating, reflection is typically reduced to less than one percent.

Plastic containers with a gas barrier and chemical resistance

Because of their manifest benefits as packaging materials, many manufacturers have converted from glass and metal packaging to plastics. Plastics do not, however, have the barrier to gases or the chemical resistance of glass. As a result, there has been a continuous search for ways to improve the barrier properties of plastics to accommodate more and more sensitive products or to increase the shelf life of products already packed in plastic containers. Product areas that require a better barrier include carbonated beverages (soft drinks and beer), fruit juice, cosmetics, chemicals and pharmaceuticals. There is a desire, for example, to pack many more products in PET because of its transparency and brilliance – similar to glass, but lighter to handle and unbreakable. PET does not, however, have the barrier to oxygen and carbon dioxide demanded

by many products. A 50-nm internal coating of silicon dioxide applied by the PICVD process can provide this necessary oxygen barrier to protect the contents and increase the shelf life of the products.

Due to the numbers involved and the economics, it is not possible to ship PET containers around the country for coating. The coating has to be applied in or at least close to the blow molding plant. Schott HiCotec already has experience in the design and construction of PICVD plants and the integration of these plants into commercial production. In order to meet the requirements for the coating of PET bottles, Schott HiCotec has concluded an exclusive joint development in the food and beverage area with SIG Corpoplast, a leading manufacturer of high-volume two-stage machinery for the blow molding of PET containers. The result is a barrier coating machine that reflects the complementary expertise of both compa-

The pulsed plasma process, which is the basis of PICVD, is essential in building up the adhesion layer. This ensures that the coating remains on the PET bottle even after the carbonation of the product.

The PICVD applied silicon dioxide layer on the inside of a PET bottle prevents the ingress of oxygen and the egress of carbon dioxide that would affect the taste of the product.





Schott HiCotec designs and builds complete coating plants that can be integrated into the production lines of its customers.

nies. The first machine, which can coat 10,000 PET containers per hour, will be delivered to the lead customer in the spring of 2003. In the process, the internal surface of the bottle is coated, which has many benefits. A better barrier on PET containers is an essential for further growth in the industry and the transparent PICVD coating meets all the requirements without detracting from one of the essential properties of PET – its clarity. In addition, the silicon dioxide is non-toxic and does not affect the recyclability of the PET.

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The PICVD process: Forming layers in small steps

PICVD stands for Plasma Impulse Chemical Vapor Deposition. In this process the object to be coated is placed inside the coating chamber that is evacuated to the appropriate pressure. The chamber is then flooded with the gaseous coating material. By applying energy in the form of microwaves, a plasma is generated that decomposes the coating material into silicon dioxide or titanium oxide depending on the gas used. The oxides are deposited on the surface of the article. Up to this point, the process functions like a normal plasma-enhanced chemical vapor deposition process. The unique feature of PICVD is the "I" for Impulse, i.e. the plasma is pulsed. This adds a number of benefits to the process. The microwave

on/off period can be controlled to maintain the coating temperature appropriate to the plastic. Reaction products are swept out of the chamber during the "off" period. When the plasma is ignited again, the chamber is full of the pure coating gas. This leads to faster coating time and a homogeneous coating, as depletion of the coating gas close to the surface is avoided. The gas composition can also be changed. This is critical to the formation of the adhesion layer. Thus the overall coating is built up in small steps, leading to a dense and homogeneous coating. The entire process can be monitored in a number of ways, ensuring precise control of the process and consistency in the coating quality.