Openair® plasma in multi-component injection molding and extrusion

Openair® plasma makes it possible to use low-cost structural plastics when molding rigid-flexible and rigid-rigid combinations

Joints between different materials in composites play a major role in industry. By joining different components a product can be given new physical properties which the individual materials do not possess alone. This allows products to be made which exhibit great rigidity and strength while simultaneously having a surface that is both flexible and pleasantly tactile.

Rigid-flexible combinations of low-cost materials such as polypropylene (PP) with TPUs (thermoplastic polyurethanes) have not been possible to date because the TPU did not adhere to the PP. When designing components manufacturers were forced to use the more expensive PC/ABS. Pretreatment by means of Openair® Plasma now makes it possible to achieve joints between PP-PA, PA-PA, PA12-PA6, PE-PA6, PBT-PA6 and between unmodified TPEs amongst others. Today, across Europe some 36 million tons of PP are produced. Of this, an average 45 kg is found within every automobile. The advent of plasma treatment will only allow this to grow, leading to cost-savings in many areas of production.

Now it is possible to mold parts with a thin skin of TPU having tactile, user interface properties while providing rigidity with low-cost PP. This can eliminate the need for problematic PU soft-touch paints and simplify production. PP is being increasingly used to manufacture products in which the described rigid-flexible characteristic is a requirement.

The advantage of operating at normal pressure (ambient conditions) and the compact configuration of the plasma generator allows for numerous novel applications in multi-component injection molding and extrusion. With the aid of Openair® plasma technology TPU can now be injected directly onto materials that previously could not be directly joined.

Possible applications include the imbedding of handles within skin materials or conversely, the molding of seals inside a rigid component. Rigid-Rigid material combinations are ideally suited to housing applications, allowing for improved performance while also lowering costs. As the adjacent table shows, PP is not the only plastic for which Openair® plasma can be used to produce rigid-rigid joints. Numerous new combinations of materials can now be implemented.

Protective padding or ductile user interfaces are necessary for many products such as tools, suitcases, housings and functional parts for household systems like coffee machines or toasters.

Multi-shot molded products made using the Openair® Plasma process exhibit:

- Powerful adhesion
- Enormous cost savings (use of alternative combinations of materials)
- Simple processing with pretreatment in the mold or in-line with extrusion
- Extensive quality improvement

Fig. 1: Use of Openair® Plasma in a two-component injection molding machine

Fig. 2: TPU composite adhesion table

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With reference to the TPU, treatment with Openair® plasma brings about activation of the surface of the material. OH groups are formed on the surface which undergo strong chemical bonding to reactive constituents of the second component (TPU). Through isocyanate functional groups durable bonds are produced.

**Process:**

After extrusion or injection of the first component the contact surface between the materials is briefly activated with plasma. Following this the mold is closed again and the second component is injected on top. In extrusion the second component is extruded using an additional die.

- Adhesive bonds with TPU brought about by Openair® plasma withstand all common tests for long-term bonding strength.
- Pretreatment can take place both directly in the mold or when transferring parts to another mold.
- In-line use: By means of a simple electric connection/extension Openair® plasma technology can be integrated equally well into existing and new production lines and processes.
- The process is environmentally friendly and reduces costs.

**Mode of operation of the plasma process:**

- Activation: Physicochemical preparation of the surface onto which injection is to take place
- Cleaning: Ultrafine cleaning of the surface to remove organic residues
- Electrostatic discharging of the surface of the part
- No mechanical machining steps required

Openair® Plasma is a key technology: Constantly rising raw material prices and growing demands for quality require new technologies. For car users TPU is a modern material which is not only UV stable and resistant to discolouration but can also be employed in relatively light colours.

The creation of new adhesive composites using this material means a significant expansion of its areas of application. Atmospheric-pressure Openair® Plasma technology provides the necessary conditions for this in multi-component injection molding and extrusion.