PMMA granulate with polymer dust sticking to it (© neo-plastic)

Tiny, but Nasty

Removing Polymer Dust Can Lower Scrap Rates

When looking through transparent parts, it is not uncommon to spot specks and points. Such particles can be removed by granulate dedusters that are used not only during granulate production, but also, as is becoming more common, for producing such sophisticated parts.

Transparent molded parts are in use almost everywhere, whether right before our eyes, as reading or protective glasses, as displays for white goods and other household appliances, or in untold numbers of display disks and covers in cars. These are usually high gloss parts and made mostly from PMMA or PC, can be painted or unpainted, depending on the place of use, partially or entirely back lighted, or also be used as functional surfaces. Yet all these applications have one thing in common: there should be no small inclusions or tiny specks to impair the beholder's view.

In practice, however, wish and reality often part ways. For when one looks through such transparent parts, he can see miniscule specks and points that present a challenge for the manufacturer to eliminate. This challenge was taken up by neo-plastic Dr. Doetsch Diespeck GmbH of Diespeck, Germany, a privately owned and operated manufacturer of injection molded parts, when they began producing molded parts with high gloss transparent surfaces. In order to check the quality of the injection molded parts, they were viewed under the microscope and by the transmitted light method, among others. Thereby, various types of spots showed up in the transparent parts (**Fig. 1**). The size and position of such »

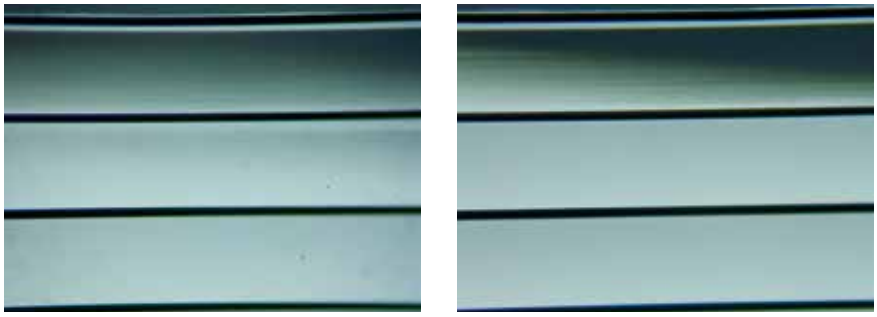

Fig. 1. Before and after: Left: specks caused by polymer dust in a transparent surface, right: speck-free part surface after the deduster was placed in operation (© neo-plastic)

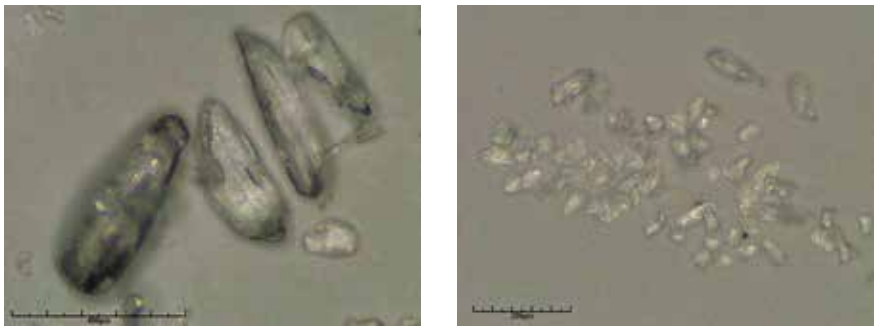

Fig. 2. Microscopic images: Left: close-up of several dust particles, right: section of the particle filter with cut dust on it (© CleanControlling)

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"pollution" varied, but it was present in a majority of the parts.

Systematic Cause Research Indicates the Source of Error

The processing of highly transparent materials, such as PMMA, makes special demands on cleanliness in the process. neo-plastic has plasticizing units with materials handling as well as materials drying. From its container beside the machine, PMMA granulate is sucked into the tower dryer, so that neither a central dryer, nor the conveying path to the funnel can introduce pollution. In order to detect the cause, the material was processed into a different part on another machine as a crossover experiment. On the intended injection molding machine, the critical part was produced from another type of PMMA. In both cases, however, the result was the same, allowing the unit to be excluded as the source of pollution.

Following a thorough analysis of the error image and the evaluation of measures carried out previously, it was logical to assume that polymer dust sticking to the granules might be responsible for the inclusions in the molded part and needed to be looked into more closely.

Why Tiny Particles Do Not Melt

Polymer dust or cut particles are an unavoidable result of every cutting and separating process, as well as when the material is cold-cut during granulation. No matter how sharp and fine the cutting tool blades are, fine cut dust arises when the extruded polymer strand is divided up. Since plastics are non-conductors and their electrostatic charge is not discharged, dust sticks to the granules and is delivered to the processor together with the granulate, as can be seen easily in the **Title figure**. If no remedial measures are taken, the particles will ultimately turn up as irritating inclusions in the part. These particles can be removed by employing deduster systems both when the granulate is produced and when sensitive parts are being produced.

Why do these tiny particles impair the optics of the part and do not melt in the plasticizing unit? There are several theories about this:

- These particles have a very high surface-to-weight ratio by which they bind a protective envelope of air around themselves. Due to such cushioning, they remain immobile and are carried along though and/or in the polymer melt to the surface of the part.
- Possibly due to its lower density, cut dust does not receive enough warmth during plasticizing for it to melt, too, despite high melting temperatures.

No matter which theory applies to which particular application – the particles have to be removed.

Innumerable Particles Impair Part Quality

The specialist for removing all types of dust in plastics processing is MBengineering GmbH located in Dürbheim, Germany. The company develops and builds granulate dedusters for diverse production requirements.

To get to know the technology and to be able to verify the success of the measure in production, MBengineering received 25 kg PMMA from neo-plastic for dedusting. This amount was dedusted in a granulate deduster with a drum module (type: TS20, 80–120 kg/h), whereby 4.5 g of particles were obtained. "This result made us very aware of the great error potential

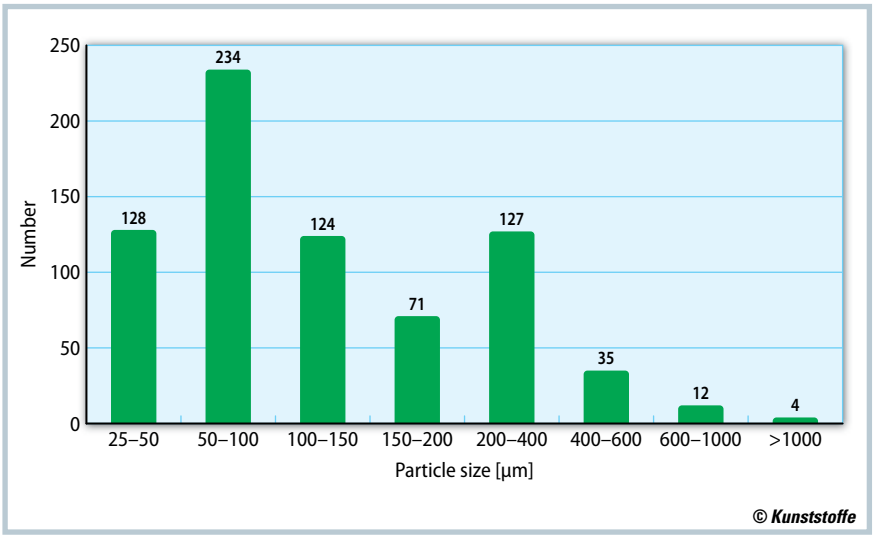

Fig. 3. Result of particle scan of PMMA granulate dust (source: CleanControlling)

in small particles," says Baron Hubertus von und zu Franckenstein, managing director of neo-plastic. "By this time, we were quite certain that the removal of cut dust would make itself felt in part quality."

In order to visualize the separated particles, several of them were measured under a materials microscope (type: HDF, manufacturer: Jomesa Messsysteme GmbH, Ismaning, Germany) using overhead lighting (**Fig. 2**; scale 0.8 µm/px). It can easily be seen that the cuts vary in shape and dimensions that can be recognized in the error pattern in the part. Since the extent of the particles is also interesting, a scanning electron microscope was used to determine them from a small amount of dust (type: EVO 40 XVP, manufacturer: Carl Zeiss Jena GmbH, Jena, Germany). All particles with a maximum extent of more than 25 µm were measured as they were being counted. The result showed that approx. 50 % of the 735 detected particles ranged in size from more than 25 µm to less than 100 µm, so that even the tiniest particles bear responsibility for the error pattern (**Fig. 3**).

Error Source Unequivocally Identified

The externally cleaned material was immediately processed to parts at neo-plastic, and the effect was obvious: the parts were nearly speck-free. "The qualification 'nearly' can be explained. The components that transport material in the injection molding machine require one or two production days before particle-free melt is in fact available for processing," explains Andreas Bauer from the Sales Department at MBengineering.

In order to confirm the result under production conditions, neo-plastic received a unit on loan. The deduster supplied is equipped with a sifter module (**Fig. 4**) specially developed for use with optical applications. This module can be mounted directly on the intake or on the tower dryer. This avoids creating new dust due to abrasion along the transport path. The device achieves a throughput of 15 kg/h.

The working principle of the system: the granulate to be cleaned is conveyed by vacuum to the sifter module. Once the required amount has been reached, prefiltered air sucked through the material bed whirls it around. An ionizing bar provides positively and negatively charged ions to neutralize existing electrical charges, so that the particles are released from the granulate corns. A sieve with a grid width of up to 2 mm permits only the particles to pass in the exhaust air current. This carries them off, and they are caught in the collection bin of the filter unit. The thus cleaned material is subsequently passed on to the funnel or tower dryer and is available for processing.

Consistent Result Opens New Markets

After just a few working shifts, the result was impeccable when the parts were viewed in transmitted light (**Fig. 1 right**). Thomas Dolansky, project leader for high gloss surfaces at neo-plastic commented:

Fig. 4. TS5 sifter module used in production at neo-plastic for dedusting PMMA granulate (© Ingenieurbüro Fischer)

"For us, it was clear in the sample phase of the project that from now on, only dedusted material will be processed, and the loaned unit will be kept on." That the sifter module performs its task very well, can be seen from the lack of cut particles on the walls of the tower dryer. The deduster is mobile, so that it can be used as required on another injection molding machine. Since the cause of the particle problem has been recognized, additional components with high gloss transparent parts can also be produced in large numbers without inclusions of particles. ■