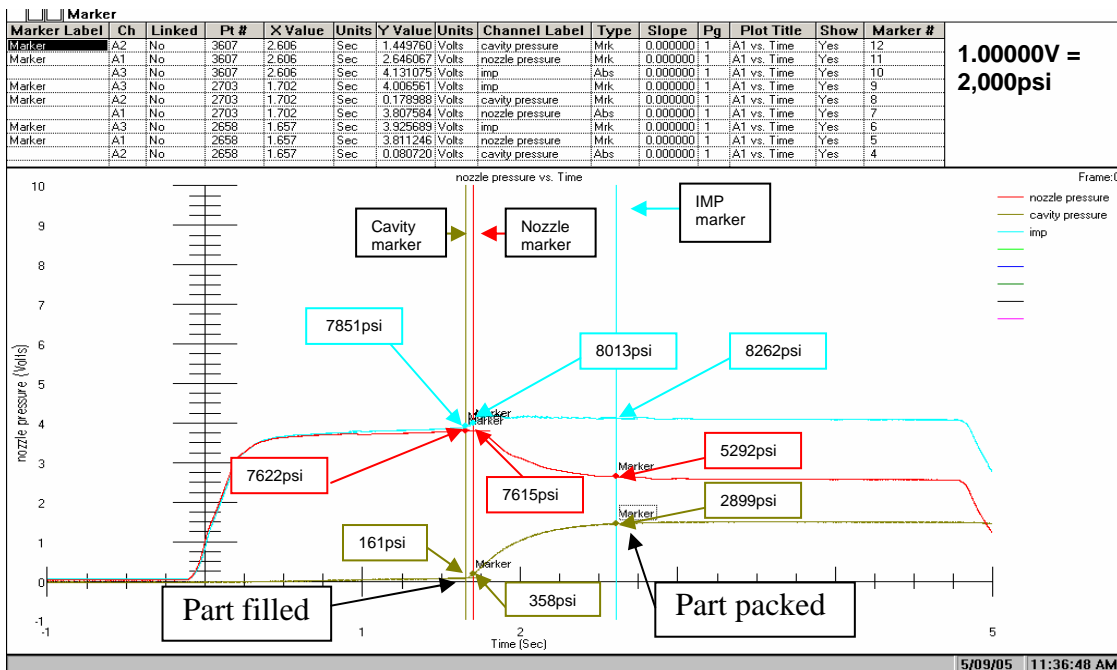




Molding from the materials point of view- Intellimold™

Materials: Squeeze, don't crush!

In our first newsletter we introduced you to our Intellimold closed loop process control technology for materials processing. For injection molding, you could say it's like cruise control on your car: set the internal melt pressure (IMP) and let it take control of the injection profile; automatically. You manually input the recommended injection pressure and injection time on the controller screen for Intellimold, and the tool is filled with molten plastic at that pressure from the time it leaves the nozzle until it almost fills the tool. I say "almost fills", because the final few milliseconds before the cavity is filled, the pressure transducer at the last place to fill senses an increase in cavity pressure and signals the nozzle pressure to proportionally decrease. (ref. Fig. 1) This gives the molten material a controlled pressure drop to holding pressure, and allows the morphology to relax. The abrupt switchover from inject to pack and hold in conventional molding changes the stress in the material at that exact point. We normally don't mind quickly accelerating in a car from a traffic light; it's the abrupt slamming on of the brakes at the red light that disturbs the passengers. If you can see the light turning yellow, you have time to apply the brakes earlier and not strain the passengers against their seatbelts.



An actual screen view from data acquisition is shown in Fig.1. The IMP is set for 8,000psi. The response of the hydraulic valve and signal conditioning of the inputs will affect the accuracy to the set point. However, at each marker line, the sums of the cavity and nozzle pressures are well within 1% of the IMP value at that line. That's continuous control on the melt even while increasing cavity to holding pressure of around 2,900psi.

Figure 1

The uncontrolled pressure transitions during fill, pack and hold pressures in conventional molding are especially disturbing to materials that have rubber or elastomer phases. More information on the comparisons between the continuous control of Intellimold and conventional control will be brought out in other newsletters.

In our last newsletter we highlighted a couple of TEM (transmission electron microscope) pictures of a TPV material comparing a conventional and Intellimold part. The rubber phase was distorted and elongated in the conventional part, while the Intellimold morphology was much more rounded. I want to give you some further examples of studies we have run on an ABS engineering grade material, and a “commodity” material such as TPO.

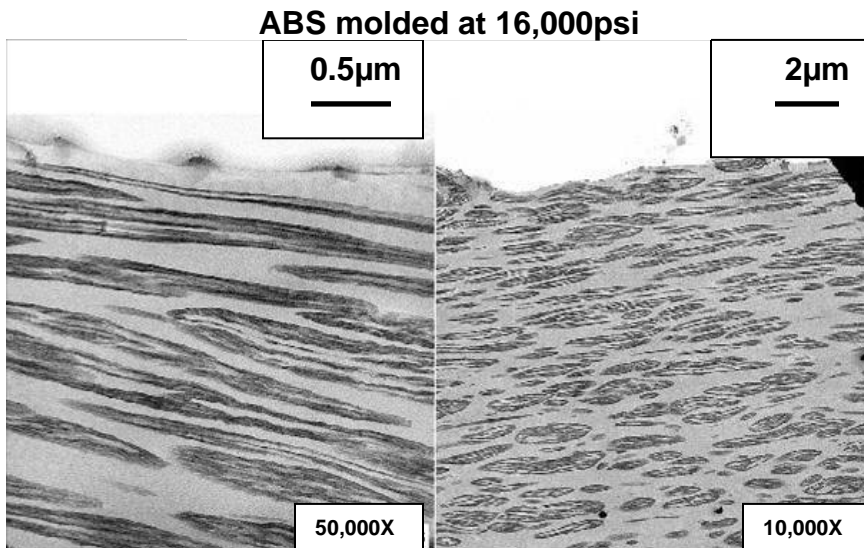


Figure 2

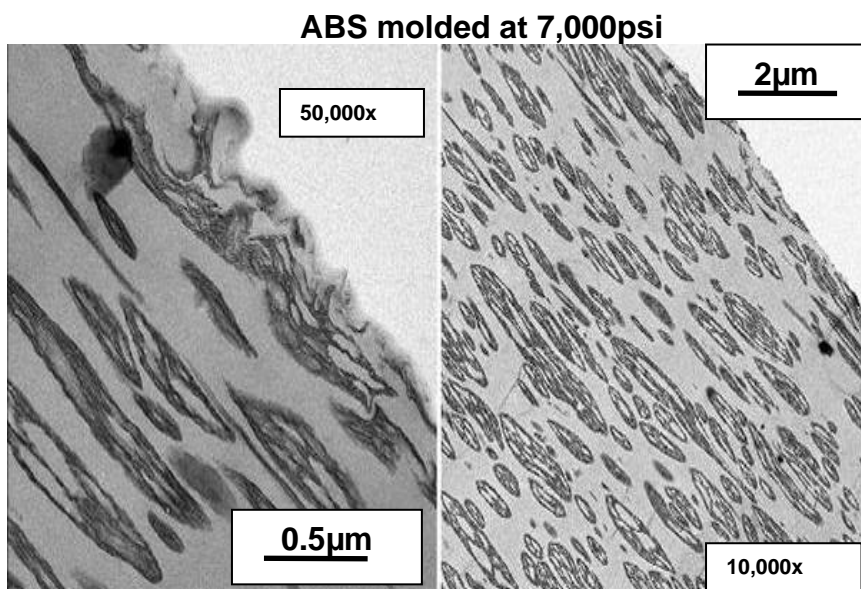


Figure 3

At typical high injection pressures for parts of about 2mm wall thickness, the rubber phase in ABS can get elongated to more than 5x the normal morphology. Compare the rubber at the surface region to the rubber about 8-10µm deep in the 10,000x picture in Fig.2. The closer to the core of the part, the more relaxed the morphology.

Now compare the morphology of the ABS molded at 7,000psi (Fig.3) to the morphology of Fig.2. You can see that the rubber particles are more oval and relaxed, even near the surface. If the elongated rubber particles are exposed to chemicals, UV light, or heat, these are much more susceptible to rupture or pulling out of the continuous phase. This can lead to lower impact properties, stress fracture at lower loads, and gloss differences. If there are secondary operations such as painting, this could lead to paint soak-in, gloss differences, or poor adhesion after drying. For parts made from plating grade ABS, the stressed rubber particles will give non-uniform surface etch, and potential adhesion loss of the plating metal during thermal cycling.

Intellimold maintains a constant pressure on the melt, therefore the stress in the melt is uniform and you have a constant part density. There is no abrupt pressure change as in conventional molding or in processes without closed loop control. With Intellimold you control pressure on the melt from the nozzle to last place to fill, every millisecond.

In the next TEM micrograph, Fig.4, you can see the comparison between a TPO part molded with Intellimold and the same part molded conventionally. The problem was a small amount of splay appearing on the Class A textured surface of the part. In order to fill the part completely and not freeze off the gate, the part was injected very fast. If the fill time was slowed down, the splay went away but the part would not fill some of the small ribs or there were areas of gloss difference. When the part was molded with Intellimold process control, the splay went away. By comparing the morphology of the rubber particles between the two processes, it can be seen Intellimold does not stress the rubber or the material, and there is no elongation of the particles. The constant melt pressure from the gate to the last place to fill allowed the material to pass through the gate without shearing the rubber phase, completely fill the part, and give the morphology time to relax to it's intended shape. No gloss differences due to change in pressure or not contacting the tool surface with equal pressure, no shearing of the rubber phase and surface splay, and a faster cycle time as a bonus!

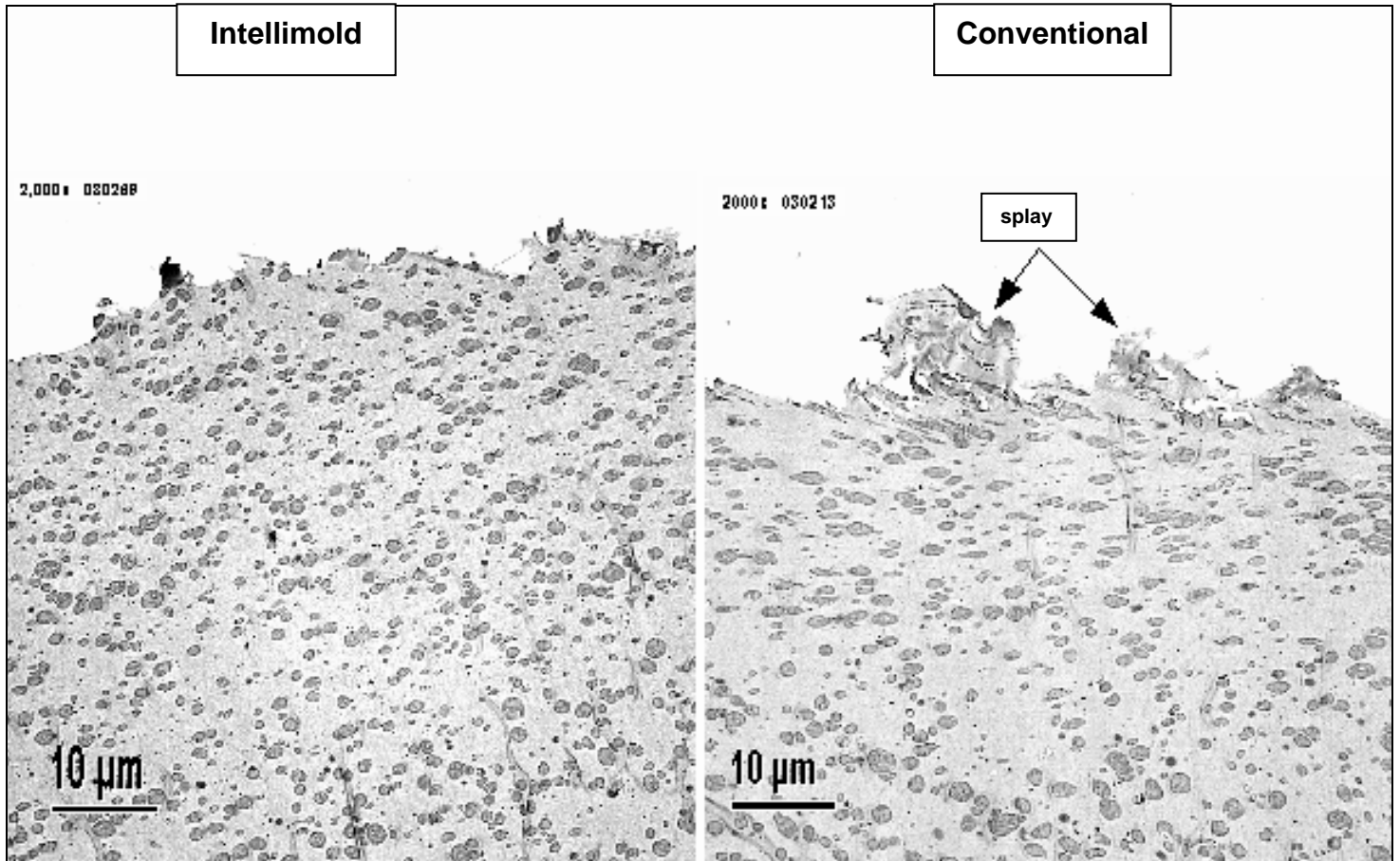


Figure 4

Summary:

Intellimold treats your material right. It doesn't cause abuse to the material due to abrupt changes in speed or pressure. Put your process on "cruise control" and produce better parts more economically with Intellimold.

Questions or Comments?

* Please contact **George Feth** at (734) 477-9344 or gfeth@mgventerprises.com