TPE-A Laser Sintering Material and Part Properties – Qualification for New Applications

Materials for laser sintering process are still rare and in focus of current research. Standard material Polyamide 12 is well known in terms of material characteristics, laser sintering process and resulting part properties. Furthermore it is applicable in a broad amount of technical cases. However Polyamide 12 is only one of numerous technical polymers and the here investigated TPE-A material supplements the material database of laser sintering. TPE-A is a thermoplastic elastomer, having elastic and simultaneously thermoplastic properties. This way it is possible to use TPE-A for the laser sintering process, realizing new applications like for bellows, seals and shoe soles. One of thermoplastic elastomer in the market is EOS's PrimePart ST, a PEBA (polyamide-based TPE), that was specifically developed for application in laser sintering. Though it is already usable on laser sintering machine, there are several aspects that have to be investigated.

1. Objectives

As the TPE material performs different from Polyamide 12 during process, powder characteristics, process parameter and part properties have to be tested. It is already known that powder characterization methods, like MVR-measurement, used for standard material PA12 to test the aging stage, aren't suitable for PrimePart ST. Therefore new procedures have to be considered, in terms of powder characterization and chemical investigations to distinguish virgin powder from thermal stressed material. Furthermore optimal process parameter, which lead to desired part characteristics are important to qualify the material for new applications of laser sintering.

2. Procedure

Since the TPE material has different polymer properties from Polyamide 12, the performance during process has to be tested. Parameters like build temperature and part thickness have to be varied. Elastic part characteristics like elongation at break analyzed by tensile test (figure 44) in correlation to build parameters of laser sintering process have to be understood, so that using PrimePart ST leads to reliable part properties. Also important for reproducible application is the aging behavior of PrimePart ST powder, due to thermal stress during laser sintering process and a targeted refreshmentrate of 50/50. This way different powder characterization methods and chemical tests are applied to investigate the difference of virgin and thermal stressed powder. Furthermore part properties like tensile behavior and discoloration of TPE parts are tested to achieve elastic laser sintering parts with applicable characteristics.

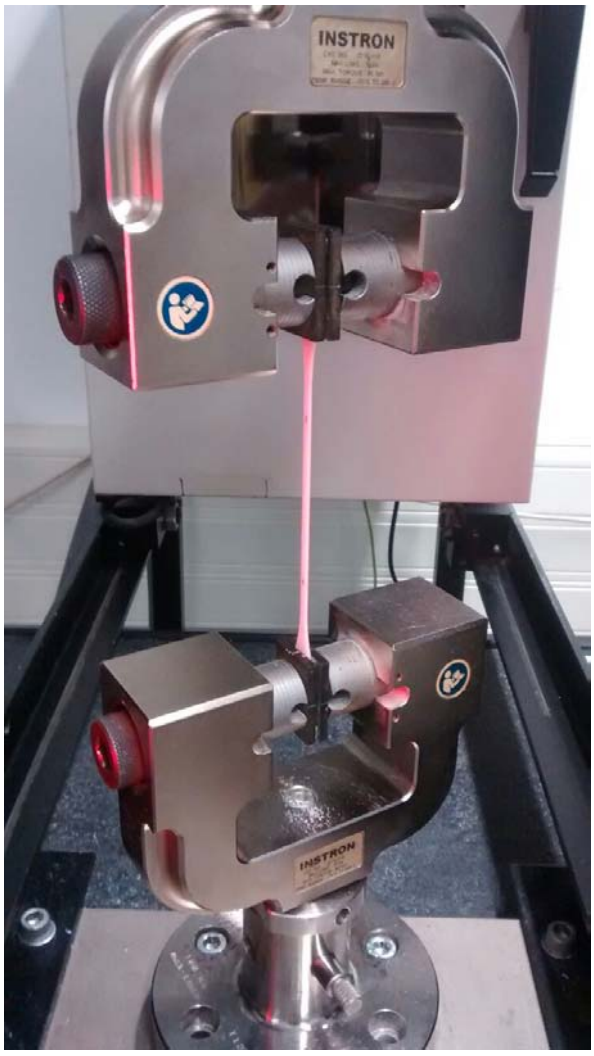

Figure 44: Tensile test of TPE specimen

3. Latest results

In former research powder was aged in an oven and in the laser sintering machine. It was find out, that after thermal stress the molecular weight of TPE powder increases slightly. Furthermore particle size distribution shifts to higher values, due to agglomeration of the particles. During compression tests, stamping dies were filled with 1.0 g of powder and were stressed with 25 kN. As you can see in figure 45, where applied load over displacement is depicted, machine aged powder (1 MA) compacts more than virgin powder (VP), as a result of mentioned agglomeration of particles. Powder that was aged two times in the machine compacts even more.

This effect can also be stated by determining bulk density. When powder is aged in the machine, bulk density is lower in comparison to virgin powder. When you test refreshed powder, namely 50 % virgin powder and 50 % aged powder, you get a medium bulk density. As a conclusion the ageing stage of the TPE material is not investigated by MVR measurement, like it is used to be done with Polyamide 12, but by determination of the bulk density.

During this year, tensile tests of specimens built at different temperatures were done. Elongation at break referred to cross section gave information about adequate build temperature at which mechanical quality is the best and dimensions are still correct.

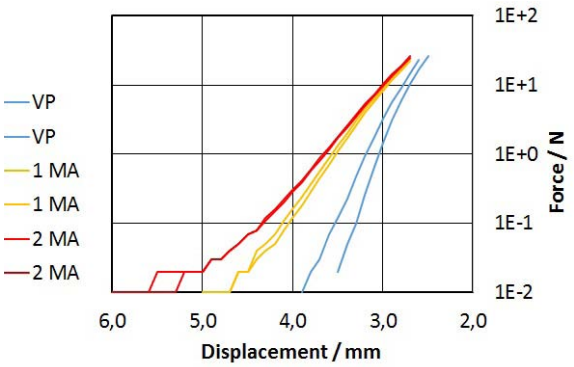

Figure 45: Powder Compression of virgin and machine aged powder

Furthermore a discoloration of parts, built with PrimePart ST, was noticed. Within one build job you can see yellow parts in varying intense. To investigate when discoloration occurs, parameters like laser energy density, wall thickness and orientation of therewith built parts are varied to build specimens for color measurement. The color measurement takes place by spectrophotometry with Minolta Spectrophotometer CM – 3600d in KTP (Kunststofftechnik Paderborn) laboratory. Yellowness is estimated according to DIN 6167 and related to before mentioned parameters. Furthermore it is tested if yellowness affects mechanical quality.

4 Outlook

Research into yellowness of TPE parts and tensile tests will be finished and a final report will be prepared.

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