3-D Printed Mold Inserts for Short-Run Injection Molding

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ABSTRACT

Injection molding, even for prototypes or short-runs, can take weeks and thousands of dollars to develop and manufacture. Using Additive Manufacturing (i.e., 3-D Printing [1]) to produce made-to-size inserts for injection molds has the potential to drastically reduce those costs and time to produce. Prototype injection molds are used to produce short runs of parts to be utilized in quoting customers' requirements. Injection molds are primarily manufactured using tool steels which can withstand the high temperature environment as well as well as mechanical and thermal fatigue.

It is important to understand the methods and concepts of injection molding when developing an additively manufactured plastic mold that will be used as an insert for plastic injection molding, i.e. rapid tooling [4,5]. Several variables need to be taken into consideration during injection molding, e.g., compression pressure, hold time, and cooling. Compression affects injection molded parts in terms of quality, due to part deformation caused by volumetric shrinkage [2]. Volumetric shrinkage is the reduction of molecule size in a particular plastic when changing between molten and solid states. Compression also affects the proper sealing of the mold halves, without a proper seal flashing is likely to occur. This aspect was considered in our design by using an injection mold that is placed into a steel mold [3]. The compression ratios then needed to be studied and adjusted in the design of the molds.

Functional insert molds (Figure 1) were developed and analyzed with CAE software packages for modeling, stress analysis (Figure 2), and injection molding simulation (Figure 3). The developed inserts were fabricated on a 3D printer [6], and tested using an industrial plastic injection molding unit. Calculations for cooling and mold compression were used to develop guidelines for future parts, with measurements taken to validate calculations and dimensions on the molded parts. Several sets of inserts were tested, and results show the potential of this type of inserts for specific applications (Figure 4). Thus, a company could rapidly and efficiently produce functional parts for quoting for prospective clients.

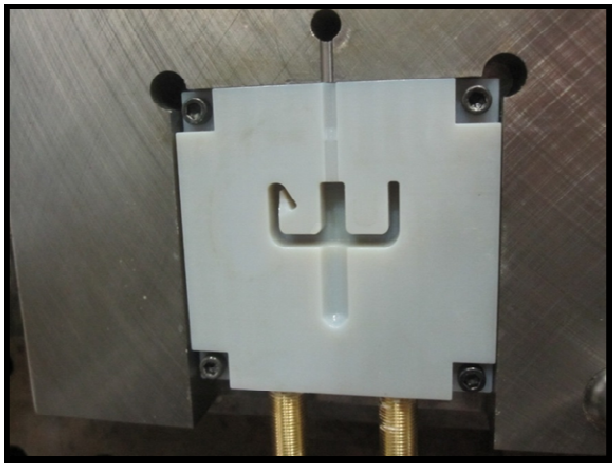

Figure 1. 3D Printed Insert on Injection Molding Machine.

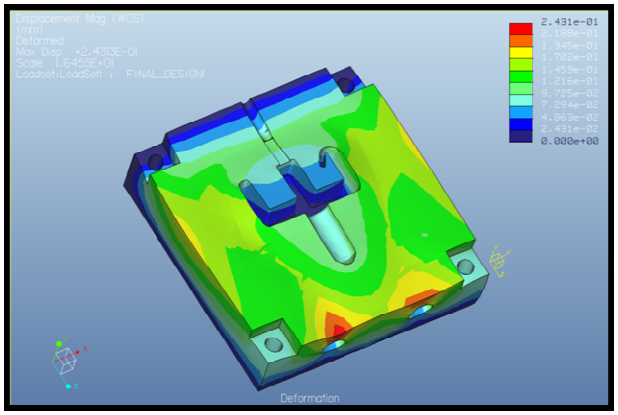

Figure 2. Mechanical Analysis of 3D Printed Insert.

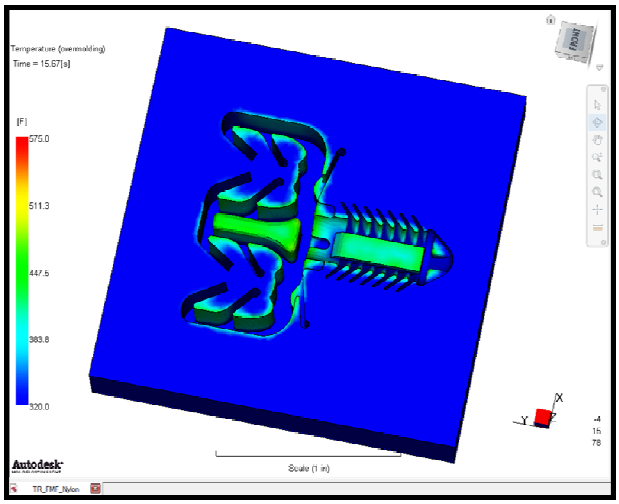

Figure 3. Injection Molding Flow Simulation.

Figure 4. Injection Molded Part.

Conclusions

This feasibility study has provided positive results, indicating that the use of 3D printed inserts are a viable option for short runs of injection molded parts. There still are additional testing that needs to be performed in order to have a better understanding of 3D printing applicability, something that has been undertaken as complementary project.

Bibliography

1. *3D Printing*. (n.d.). Retrieved 7 14, 2012, from http://en. wikipedia.org/wiki/Additive_manufacturing
2. Dickens, P. (2000). Failure Mechanism Analsyis of Stereolithographic Injection Mould Tooling. *Rapid Prototyping Journal*, 62-74.
3. DLG. (2012). *Digital Lab Graph*. Retrieved Feb. 12, 2012, from http://factoryoffactories.com/rapidtool.htm
4. Jacobs, P. F. (1996). Recent advances in rapid tooling for Stereolithography. *Proceedings of the National Conference on Rapid Prototyping and Tooling Research* (pp. 18-19). Buckinghamshire: Buckinghamshire College.
5. Jacobs, P. F., & Hilton, P. D. (2000). Rapid Tooling: Technologies and Industrial Applications. In P. F. Peter D. Hilton. New York: Marcel Dekker.
6. Objet 3D Printers. (2012, 6 5). *New Objet Materials: The power behind your 3D Printer*. Retrieved 2012, from http://www.objet.com/Portals/0/docs2/New% 20 materials%20data%20sheets_low%20res.pdf

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