Efficient manufacturing process for metal bipolar-plates using FDM-Mold

This project is funded by the DBU – "Deutsche Bundesstiftung Umwelt" and runs in cooperation with Eisenhuth and an associated automotive OEM. The research question in this project is, if the FDM process is suitable for the production of tool inserts (negative molds), which enables the production of finely textured metallic bipolar plates (BPP). Therefore different flow field designs are manufactured and tested at the DMRC. Moreover a suitable FDM-Material has to be identified which fulfills the requirements and loads for the molding process of thin metallic plates.

1. Objectives

The first part of the Project was to define and design the finely structured hydrogen channel, taking the requirements of the subsequent production steps into account. There, the limitations of the FDM-Process in this area of application and the resulting mechanical properties and geometrical characteristics has to be investigated.

2. Procedure

In the first work package, Eisenhuth designed a suitable geometry of a BPP and the negative mold was realiszied at the DMRC. In a second step the DMRC identified different thermoplastics. Subsequently extensive investigations on the optimal FDM-Parameters for building fine structures started. After the first negative mold was built, the mold was geometrically measured at the DMRC and Eisenhuth performs first molding tests. The gained results were used to optimize the shape and the production process.

3. Latest results

To optimize the channel geometries, the line waviness was mesured using the 3D Keyence macroscope. Best results were reached with Ultem, 90 degrees, horizontally with 0.53 mm canal depth in average. For the ABS material, sufficient results were reached for both orientations. In case of horizontal orientation, there may be problems due to increased attrition caused by the waves on the bars. The individual results are shown in Figure 16.

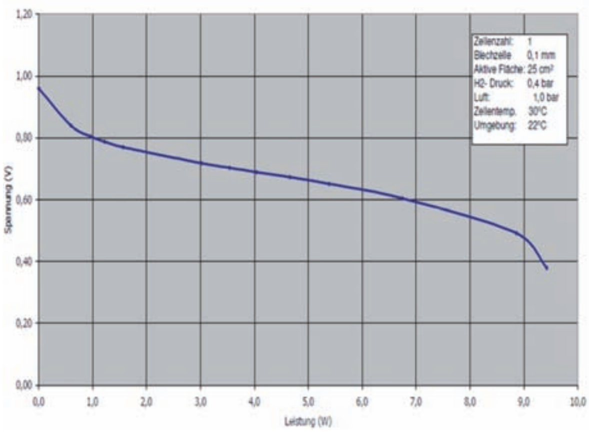


Figure 16: Results of 3D Keyence macroscope

Figure 17 shows the power-voltage-characteristics of the single fluid cell. The voltage was plotted over the power. The single cell has an output of 7W at the optimal operating point of 0.6 V. Thus, the finished plates are suitable for constructing a stack (shown in Innovations). The performance is about 470 mA/cm² with 0.6 V operating voltage. A comparable cell with a graphitic plate (current SoA) has a power of 290 mA/cm².

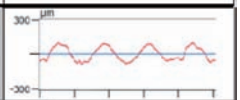
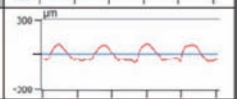
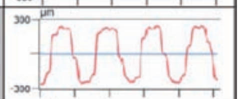
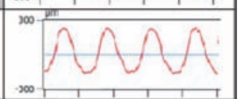
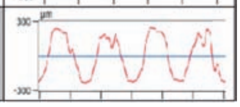
Material	Kanaltiefen in mm	Bemerkung	
Ultem 75 Grad Senkrecht	~0,18	• Ungleichmäßige Kanaltiefen • Rastlinien	
Ultem 90 Grad Senkrecht	~0,15	• Gleichmäßige Kanaltiefen • Rastlinien	
Ultem 90 Grad Waagerecht	0,53	• Sehr gleichmäßige Kanaltiefen • Leichte Zacken auf dem Steg	
ABS 90 Grad Senkrecht	0,40	• Gleichmäßige Kanaltiefen	
ABS 90 Grad Waagerecht	0,48	• Sehr gleichmäßige Kanaltiefen • Zacken auf dem Steg	

Figure 17: Power-Voltage-Character-

4. Outlook

Overall, the project has been successful. It is generally possible to produce sheet metal plates using prototype mold of a FDM-machine. The mechanical values are sufficient to produce a small series of sheet metal cells. Ultem and PC are most suitable as starting materials, because the attrition is up to 230% lower than ABS material. To obtain the homogeneous surface the process parameters and the strategy has to be adapted. The use of the technology is also conceivable in other applications, such as heat exchangers.

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