RESISTIVITY MEASUREMENT ON 3D PRINTED SAMPLES

Plasty Mladeč (Filament PM)

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1. Introduction

A resistivity measurement was agreed between Plasty Mladeč | Filament PM (PM) and ORLEN Unipetrol RPA s.r.o. - POLYMER INSTITUTE BRNO branch (PIB). The measurement included measuring of delivered 3D printed specimens from ESD PETG material produced by PM. Delivered specimens were printed in two different arrangements. First, the main surface was laying down on the heated bed (horizontal). Second arrangement included the minor surface touching the heated bed, specimens were standing straight (vertical). These arrangements were printed to study the in-layer and cross-layer differences in resistivity.

2. Material description

PIB has received 2 types of specimens printed in two arrangements described above. The samples were printed from the pilot ESD PETG from PM tagged as:
- Makroplus CC 1010 PETG_2, tisk naležato, MK4S, 270 °C/90 °C,
- Makroplus CC 1010 PETG_2, tisk nastojato, MK4S, 270 °C/90 °C.

3. Arranged analysis and procedures

Specimens were analyzed according to ČSN EN 61340-2-3: Elektrostatika, which is heavily relating to ČSN EN ISO 3915: Plasty - měření odporu vodivých plastů. The specimens were obtained from PM by their 3D printing in horizontal and vertical orientation on FDM type printer (Prusa MK4S). The specimens were beams with dimensions 90 × 10 × 3 mm. Each sample consisted of 5 specimens. Fischer-Elektronik Milli-TO3 ohmmeter was used together with four-pole electrode 4P-1 to measure volume resistivity of delivered samples. The measurement required voltage of 0.01 mV and total measurement time was 60 s to get the final value. Sample conditioning and measurement was performed at 26 °C, 33% RH for 48 h.

A brief test illustration is visible in the *Figure 1*. All summarized results can be found in another chapter in *Table 1*.

Figure 1: Test illustration - Milli-TO3 ohmmeter connected with four-pole electrode 4P-1

4. Results and commentary

Results from all analyses are shown in *Table 1*.

Table 1: Volume resistivity of delivered 3D printed samples in horizontal and vertical arrangement according to ČSN EN ISO 3915

Measurement #	Makroplus CC 1010/PETG_2 tisk naležato MK4S 270 °C/90 °C	Makroplus CC 1010/PETG_2 tisk nastojato MK4S 270 °C/90 °C
1	28.05	47.1
2	26.83	46.5
3	26.53	46.1
4	26.98	46.6
5	28.72	44.3
Average Volume resistivity (Ω·cm)	**2.7 ± 0.1**	**4.6 ± 0.1**

The results above suggest, that there is a minor difference in the volume resistivity performance. The values are still in the numerical order, the ones printed vertically tend to have higher volume resistivity. The cross-layer conductivity is slightly worse to in-layer conductivity. The main reason is, that 3D printing additional process is leading to worse layer-to-layer connection of the conductive carbon black chains present in the filament. Additionally, the main value of interest, which shoulde be considered is the horizontal one, since the electrical discharge will always find a path with the lowest resistance. Therefore, the one with lower volume resistivity, which is in the in-layer direction to neutralize itself.

5. Conclusion

PIB has measured the volume resistivity on specimens printed from Makroplus CC 1010/PETG_2 in horizontal and vertical arrangements. Specifically, the horizontally printed specimens performed slightly better and reached lower volume resistivity values. Nevertheless, the difference is minor and the overall performance is reaching similar values to compact extruded sheets. Also, the electrical discharge will always find a path with the lowest resistance, so the horizontal values should be the most relevant one.

Author confirms the data accuracy and correctness related only to the measured and evaluated samples. Commentary and conclusion is based on the experimental data gathered throughout the arranged experiments. It is not allowed to misinterpret any results or share any part of them unless the whole report is reproduced.

In Brno

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