Data Descriptor

Tribological Properties of Thermoplastic Materials Formed by 3D Printing by FDM Process

Jacek Łubiński[1*]

[1] Faculty of Mechanical Engineering and Ship Technology, Gdańsk University of Technology (11/12 Gabriela Narutowicza Street, Gdańsk, Poland)

[*] Correspondence author: jacek.lubinski@pg.edu.pl; ORCID: 0000-0003-0852-8400

Abstract

The dataset entitled 3D printed ABS thermoplastic vs. steel. Dry sliding wear test in constant load & velocity ring on flat configuration. Test parameters: print layer thickness and orientation. Test symbol: 019_h_4 contains: the time base (expressed in seconds and minutes), the friction torque for sliding friction, rotational velocity of the counter – specimen (velocity of sliding), friction coefficient, load in the friction contact interface, specimen temperature. Tests were conducted in an in-house developed tribological tester, the Tribometr PT-1. The test belongs to a testing program on the influence of technological parameters in 3D printing from thermoplastic materials by FDM process on friction in sliding with a steel counter – specimen without added lubrication.

Keywords: tribology, 3D printing, sliding friction, tribological wear, thermoplastic polymers

https://doi.org/10.34808/x55q-sz53_dyr_roz35

Specification table (data records)

Subject area	Mechanical engineering, tribology, sliding friction, experimental testing
More specific subject area	Measurements of tribological performance of a flat – on – flat unidirectional sliding contact of C45 annealed steel and ABS polymeric specimen (3D print by FDM process)
Type of data	Text
How the data was acquired	The data were collected at the Gdańsk University of Technology using the universal tribological test rig Tribometr PT-1

Data format	The tables are in .xls format
Experimental factors	Most of the data contained in the dataset were not processed. The friction coefficient was calculated in post-processing
Experimental features	The samples were manufactured in a 3D printing FDM process (Zortrax Inventure) from ABS filament
Data source location	MOST Wiedzy Open Research Catalog, Gdańsk University of Technology, Gdańsk, Poland
Data accessibility	The dataset is accessible and is publicly and freely available for any research or educational purposes

Background

There is well-established interest in furthering knowledge on the tribological performance of the polymer-metal sliding combination under dry friction, which was presented, for example, in Mithun V. et al. (2016). The onset of rapid prototyping technologies sparked works on the impact of the FDM technology parameters on the tribological parameters. In the work by Kozior T. and Kundera C. (2018), the influence of the printing positions of ABS specimens on wear in sliding friction is observed. A similar study by Mithulin V. et al. (2016) investigates the tribological performance of ABS and PA6 polymer-metal sliding contact in dry friction with the focus on the influence of heat on the process. Despite the emerging new works on the problems of friction and wear in the sliding of components manufactured in a 3D printing process, the area of knowledge still remains in great need of further research effort.

Our dataset, 3D printed ABS thermoplastic vs. steel. Dry sliding wear test in constant load & velocity ring on flat configuration. Test parameters: print layer thickness and orientation. Test symbol: 019_h_4, was created to evaluate the friction coefficient in sliding friction in a unique combination of materials. The particular test is one in a series performed to look into the influence of additive manufacturing process parameters on the tribological interaction between a steel specimen and a structured ABS plastic specimen deposited in layers of hot filament setting incrementally. The dataset contains: the input parameters of the test (load, velocity) and output (friction torque/coefficient, temperature of the polymeric specimen). The observed torque and input load were used to calculate the friction coefficient.

Methods

The tests were conducted in a custom-developed tribological test rig, the Tribometr PT-1. The geometry of the test set-up is presented in Fig. 35.1. The top specimen (cylindrical) is made of C45 steel, annealed to approx. 45 HRC and ground to a roughness of Ra < 0.32 μm. The bottom specimen is printed in the FDM 3D printing process and is used without any machining of the usable faces.

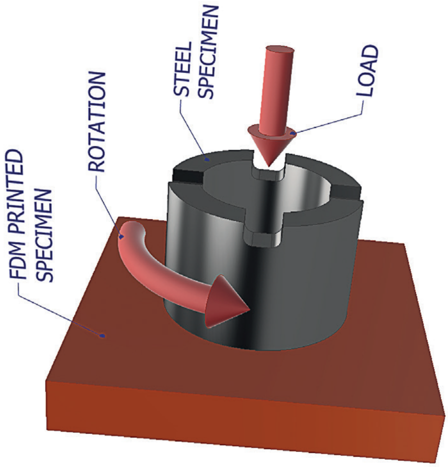

Fig. 35.1. Specimen setup geometry as used in the Tribometr PT-1 test rig

The ABS specimens are aged for a minimum of 48h to allow for relaxation of the residual stress and normal saturation with moisture and atmospheric gases. The test load is equal to FN = 410 N (mean contact pressure of pav = 0.5 MPa). The mean radius of the ring-shaped contact is equal to Rav = 0.0093 m = 9.3 mm. The rotational velocity of the spindle was set at 110 RPM (average sliding velocity of approx. 0.1 m/s). The test run lasted 30 min.

Data quality and availability

All of the polymeric (ABS) specimens were printed in a Zortrax Inventure printer (FDM process) from the same batch of filament. The specimens' technological variation comprised the thickness of a single layer of polymer deposited in one pass and the orientation of the specimen with respect to the printing table. The specimens were fabricated with the working face either parallel or perpendicular to the printing table. The tests were carried out in an air-conditioned room, at a temperature of 20°C and 60% relative humidity of ambient air.

The relative error in the measurement of load (force normal to the friction interface), friction torque, rotational velocity and temperature, was no greater than 1.5%. The linear dimensions of the contact zone were measured with the accuracy of 0.01 mm.

Dataset DOI
10.34808/tnbp-4r39

Acknowledgements
The generation of this dataset was supported by statutory research grants from Gdańsk University of Technology.

References

Hugo, I., Medellín-Castillo, J.E. and Pedraza, T. (2009) 'Rapid Prototyping and Manufacturing: A Review of Current Technologies', *Proceedings of the ASME 2009 International Mechanical Engineering Congress and Exposition, 4: Design and Manufacturing*. Lake Buena Vista, Florida, USA, pp. 609–621. ASME., DOI: 10.1115/IMECE2009-11750.

Kozior, T. and Kundera, C. (2018) 'An analysis of the impact of the FDM technology parameters on tribological properties', *Tribologia,* 5, pp. 33–40. DOI: 10.5604/01.3001.0012.7651.

Krasmik, V. and Schlattmann, J. (2017) 'Study of the friction and wear behavior of metal/polymer-metal multi-material configurations', *Key Engineering Materials*, 739, pp. 211–219, DOI: 10.4028/www.scientific.net/KEM.739.211.

Kar, M.K. and Bahadur, S. (1978) 'Micromechanism of wear at polymer-metal sliding interface', *Wear*, 46(1), pp. 189–202, DOI: 10.1016/0043-1648(78)90120-5.

Kulkarni, M.V. et al. (2016) 'Tribological behaviours of ABS and PA6 polymer-metal sliding combinations under dry friction, water absorbed and electroplated conditions', *Journal of Engineering Science and Technology*, 11(1), pp. 068–084. Available at: https://jestec.taylors.edu.my/Vol%2011%20issue%201%20January%202016/Volume%20(11)%20Issue%20(1)%20068-%20084.pdf (Accessed: 26th May 2022).

Boparai, K.S., Singh, R. and Singh, H. (2016) 'Wear behavior of FDM parts fabricated by composite material feed stock filament', *Rapid Prototyping Journal*, 22(2), pp. 350–357, DOI: 10.1108/RPJ-06-2014-0076.

Sudeepan, J. et al. (2014) 'Study of Friction and Wear of ABS/ZnO Polymer Composite Using Taguchi Technique', *Procedia Materials Science*, 6, pp. 391–400, DOI: 10.1016/j.mspro.2014.07.050.