EXPERIMENTAL INVESTIGATION ON THE EFFECT OF ROUGHNESS AND WETTABILITY ON TRIBOLOGICAL PROPERTIES OF METALLIC SURFACES PREPARED BY EDM

Dimitrios Skondras-Giousios [a*], Nikolaos Rogkas [b], Panagiotis Karmiris-Obratański [a,c], Angelos P. Markopoulos[a], Vasilios Spitas [b]
*diskogi@mail.ntua.gr
[a] Laboratory of Manufacturing Technology, School of Mechanical Engineering, National Technical University of Athens, Heroon Polytechniou 9, 15780 Athens, Greece
[b] Laboratory of Machine Design and Dynamics, School of Mechanical Engineering, National Technical University of Athens, 9 Iroon Polytechniou, 15780 Zografou, Athens, Greece
[c] Department of Manufacturing Systems, Faculty of Mechanical Engineering and Robotics, AGH University of Krakow, 30–059 Cracow, Poland

KEYWORDS
Texturation; Surface topography; Friction; Wettability

ABSTRACT
Energy dissipation is an inherent phenomenon observed on all tribopairs that its increase could result in deteriorating functionality or economic losses concerning various industrial applications. Approaches to avoid such undesired effects of friction include the use new lubricants, coatings or texturing of the surfaces. Concerning cases of wet friction, surface energy can affect the interaction between the participating surfaces and the lubricant. The interfacial energy dictates the wettability of the surface, thus affecting the tribological outcome of lubricated contacts. In this context, the inherent wettability of the tribopairs can influence the friction [1]. Wettability of a surface is as well affected by its roughness variation, influencing friction and the resulting wear [2]. The utilization of manufacturing methods such as laser processing can effectively control the texture and wettability of surfaces involved in lubricated contacts [3].

A facile, one-step manufacturing method to control the surface micro-topography and induce a wettability transition on metallic surfaces that has recently been utilized is the process of Electrical Discharge Machining (EDM). Different combinations of the machining parameters will lead to the fabrication surfaces possessing different roughness values. In this study, the EDM process is utilized for the manufacturing of surfaces with different wettabilities by controlling the surface texture. The influence of surface texture and wettability on friction, wear and drag on the metallic surfaces is then investigated.

Surfaces with different roughness values were created by controlling the discharge parameters (pulse-on time, current and voltage), which intensity of discharge channels that erode the workpiece. Surface topography and areal roughness parameters were obtained by a surface roughness stylus profilometer. Consequently, contact angle measurements for liquids with different surface tensions (water-oil) were obtained from all fabricated samples in order to evaluate their wettability attributes. Subsequently, the samples were tested on a pin-on-disc setup for obtaining the friction coefficient results for different sliding speeds and loads, under boundary lubrication regime. The wear outcome is measured through wear mass loss and surface topography inspection. Finally, drag torque measurements were obtained for the investigation of drag reduction efficiency of each fabricated surface.

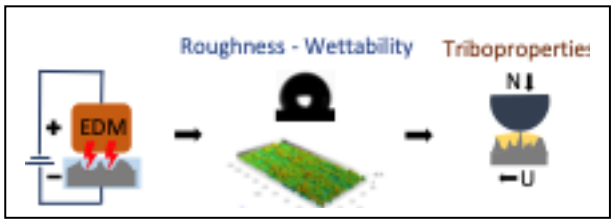

Fig.1. Graphical abstract of the study.

In conclusion, this study is expected to provide an insight on the relationship between tribological properties with roughness parameters and wettability of surfaces with different topographies, manufactured via the EDM process.

ACKNOWLEDGMENTS
This research has received funding from the Basic Research program of National Technical University of Athens under the project titled "**WetSURF**: From micro to macro scale—nature-inspired hierarchical surfaces for tribology."

REFERENCES
[1] Pawlak, Z., Urbaniak, W., & Oloyede, A. (2011). The relationship between friction and wettability in aqueous environment. Wear, 271(9-10), 1745-1749.
[2] Wojciechowski, L., Kubiak, K. J., & Mathia, T. G. (2016). Roughness and wettability of surfaces in boundary lubricated scuffing wear. Tribology International, 93, 593-601.
[3] Hao, X., Sun, P., Xiao, S., Yang, Y., & Li, L. (2020). Tribological performance of surface with different wettability under ball-on-disc test. Applied Surface Science, 501, 144228.