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EDITORIAL
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Editorial: Friction and Multi-Field Problems in Sliding Contacts

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Editorial on the Research Topic

Friction and Multi-Field Problems in Sliding Contacts

Friction inevitably occurs in the form of shear stress between rubbing surfaces in machine components and many natural structures because of the solid interaction and adhesion. In the early days of tribology, few classic frictional problems (e.g., Mindlin, 1949) associated with simple contact geometries can be solved analytically using the theory of elasticity and linear viscoelasticity (Johnson, 1987; Goryacheva, 1998). Thanks to the fast growth of computational power, friction problems with complex interfaces, complicated material models and damage mechanism are solved numerically using finite element method (Wriggers, 2002). Besides the complex mechanical field, the performance and service life of the contact interface is largely influenced by multi-fields, e.g., thermal, electric, magnetic, acoustic and, chemical field (Wang and Zhu, 2019). Thermal field is commonly coupled with the mechanical field due to the heat generation between the contacting asperities, especially at high sliding speed. One of the representative phenomena thermoelastic instability (Barber, 2018). Thermal stresses can induce partial slip of surfaces in the vicinity of thermoinsulated (Malanchuk et al., 2011) and medium-filled (Chumak et al., 2014) surface irregularities. Electrical connector is a typical example of coupled mechanical-thermal-electrical problem (Holm, 2013). The asperity contact between mating terminals greatly constricts the electric field so that the current only flows through the tiny contact area which causes a larger contact resistance and higher energy waste through Joule heating. In the finger-pad interaction, the tribo-charges can enhance the adhesion between skin and pad through the Coulomb force. This can eventually alter the real contact area and friction (Persson, 2018). Triboelectric nanogenerator (TENG) is another heat area where the mechanical field is strongly coupled with the electromagnetic field (Wang et al., 2016). TENG relies on the tribo-charges, generated within the real contact area between two sliding surfaces, to transform the kinetic energy into the electricity (Xu et al., 2020). Magnetic field can be either measured by using TENG as a magnetic sensor (Yang et al., 2012) or can be used to achieve the wireless power transmission (Cao et al., 2019). The acoustic method is commonly as an alternative to reduce the friction in machine components (Mahajan et al., 2008). In other areas, e.g., haptics (Wiertlewski et al., 2016) and ultrasonic actuator (Zhao, 2011), it is applied to tune the friction. The chemical field is commonly coupled with thermal field and other environmental factors. Heat generation between contacting asperities accelerate the chemical reaction on the interface. Important topics include the formation of tribo-film (Spikes, 2004; Brizmer et al., 2017) and tribo-emission (Wang et al., 2019).

A total of six papers are included in this article collection. At the single asperity contact level, the classic Cattaneo-Mindlin partial slip problem was extended to cover more complex interfacial geometry (Klimchuk and Ostryk). The bilinear strain hardening law was introduced to the seminar work of Jackson and Green asperity contact model (Ghaednia et al.). Effect of surface layer on the sliding contact between a rigid indenter and a viscoelastic half-space was studied using

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boundary element method (Torskaya and Stepanov). At the rough surface contact level, the thermal rectification between sinusoidal waviness surfaces with trapped interstitial gas was solved using an analyticonumerical approach (Chumak and Martynyak). A simplified theory of electroadhesion for rough interface was built upon the Persson's theory of contact (Ciavarella and Papangelo). A simple estimation of the adhesion forces between rough surfaces was achieved using bearing area model. Finally, an analytical framework for developing multi-scale thermo-electro-mechanical approach for rough surface contact was proposed (Komvopoulos).

We hope the readers can find the latest accomplishment in the multi-field modeling of the tribological problems. We would like to thank all authors contributing in this article collection.

AUTHOR CONTRIBUTIONS

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