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Editorial

FOREWORD TO THE SPECIAL ISSUE: *INTERPLAY OF MECHANICS, TRIBOLOGY AND MATERIALS SCIENCE*

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This thematic issue contains selected papers related to presentations at the International Workshop "Interplay of Mechanics, Tribology and Materials Science", Samarkand State University, September 4-16, 2023, organized by the Samarkand State University and Technische Universität Berlin. 80 participants of the workshop represented Germany, Uzbekistan, Russia, China, USA, and Slovenia. The Workshop was devoted to interdisciplinary research of mechanical and biological systems considering the interrelation and interplay of their mechanical, tribological and material aspects. In the last years, tribology has expanded to qualitatively new fields of applications, which are at the forefront of global development trends of technology and society, in particular micro- and nanotechnology as well as biology and medicine. The main challenge of tribology remains its interdisciplinary character which was in focus of the workshop. The goal of the workshop was to review the recently established concepts, tools and research activities and to outline the most important tasks for the future. The selected papers from the workshop cover a broad range of applications of contact mechanics in engineering, biology and medicine. They are devoted to the following topics:

- *Influence of tangential sliding on the contact area of a macroscopic adhesive contact* (J. Wilhayn, I.A. Lyashenko, Q. Li, V.L. Popov). Based on numerical simulations with the Boundary Element Method and experiments, the authors argue that the much-debated question of whether shear leads to an increase or decrease of contact area of an adhesive contact and contact strength, cannot be answered unambiguously as the answer depends on preloading history.
- *In silico analysis of an articular cartilage regenerative rehabilitation under conditions of mesenchymal stem cells implantation and their mechanical stimulation* (A. Poliakov, V. Pakhaliuk). The results of experimental studies and a number of successful clinical practices indicate that the treatment of joint diseases caused by damage to the articular cartilage is possible within the framework of a new medical direction - regenerative rehabilitation, which synergistically combines the methods of regenerative and rehabilitation medicine. Regenerative rehabilitation of articular cartilage defects involves the use of cellular technologies, the

effectiveness of which is enhanced by mechanical stimulation of chondrogenic cells, which accelerates their proliferation, differentiation, and formation of an extracellular matrix.

▪ *Triboinformatics: Machine learning methods for frictional instabilities* (M. Nosonovsky, A.S. Aglikov). The study of friction is traditionally a data-driven area with many experimental data and phenomenological models governing structure-property relationships. Triboinformatics is a new area combining Tribology with Machine Learning (ML) and Artificial Intelligence (AI) methods, which can help to establish correlations in data on friction and wear.

▪ *Modeling osteocyte under shock-wave therapeutic loading* (A. Smolin, G. Eremina). Dental implants have substantial significance in modern dentistry, but their osseointegration stage remains the most crucial and time-consuming step for compensating for a lost tooth. One promising approach to improve osseointegration rates is the use of extracorporeal shock wave therapy, which has shown efficacy in treating fractures, bone defects, and bone tissue regeneration in surgical and arthroplasty procedures.

▪ *Self-consistency conditions in static three-body elastic tangential contact* (E. Willert). The problem of "third body" is one of the central contemporary challenges of tribology 1. In the paper by Willert, an elementary process of the third body dynamics is considered: the contact problem for an elastic third-body particle between two elastic half-spaces. The normal and tangential contact problems are analyzed analytically considering partial slip in the contacts and the influence of third-body weight. Self-consistency conditions between global equilibrium and the contact solution are formulated to give criteria, under which circumstances static slip and stationary sliding are possible states for the third-body particle.

▪ *Selection of optimal technological parameters for forming nominally flat surfaces with lubricating microcavities* (V.P. Kuznetsov, I.V. Tatarintsev, V.V. Voropaev, A.V. Korelin). This article demonstrates a multi-step process for forming a nominally flat surface with circumferential lubricating microcavities on a tribological assembly of an X38CrSi steel shaft. The process includes finish turning, preliminary strengthening burnishing, deformation profiling of microcavities by a honing stone and smoothing of microprotrusions.

▪ *Longitudinal-radial vibrations of a viscoelastic cylindrical three-layer structure* (Kh. Khudoynazarov). Three-layer structural elements are widely used in aviation and shipbuilding, construction of buildings and structures, the space industry and other industries. The paper considers a cylindrical three-layer structure of arbitrary thickness made of viscoelastic material. Equations have been developed that enable to determine the stress-strain state at any point of an arbitrary section of a circular cylindrical three-layer viscoelastic structure based on the results of solving longitudinal-radial vibrations.

▪ *Contact interaction of an underground pipeline with soil under dynamic impacts* (K. Sultanov). Underground pipelines serve as essential engineering life support lines for the population and industry, making them crucial for the economy of any country. Hence, ensuring the strength and durability of underground pipelines is a critical and relevant problem. The paper shows that the longitudinal stress waves and their amplitudes in underground pipelines strongly depend on the law describing the process of (frictional) interaction of the underground pipeline with soil.

▪ *Experimental determination of dynamic coefficient of Amonton-Coulomb dry friction* (I. Mirzaev, Kh. Sagdiev, A. Yuvmitov, M. Turdiev, B. Egamberdiev). The purpose of the study was to experimentally determine the dynamic coefficient of dry friction between different materials under vibrations due to the initial deflection. The dry friction between the grillage and the foundation is used for the seismic isolation of buildings and structures. A measuring

complex with corresponding strain-gauge measuring channels was prepared on the laboratory one-component shaking stand to record the relative and absolute displacements of two-mass systems.

▪ *Interlayer effect of deformation and fracture of dendritic structure formed during wire-feed electron-beam additive manufacturing of Al-Si alloy* (R. Balokhonov, V. Utyaganova, D. Gatiyatullina, A. Zemlianov, V. Romanova). Interfaces and surfaces play an important role in tribology, mechanics and materials science, causing plastic strain localization and stress concentration of different spatial scales. The interfacial inhomogeneity is highly pronounced in 3D printed materials due to thermo-cycling and layer-by-layer building. In this paper, the inlayer and interlayer structure of a eutectic Al-Si alloy fabricated by wire-feed electron-beam additive manufacturing is investigated by optical and electron microscopy. Model structures inheriting the experimental morphology are created, and their deformation and fracture are simulated.

▪ *Sliding friction in contacts with one- and two-dimensional viscoelastic foundations and viscoelastic half-space* (T. Watanabe, S. Hatanaka, K. Nakano, V.L. Popov). Solid viscoelasticity is one of the essential origins of sliding friction, as every solid exhibits energy dissipation due to it during deformation processes. In this paper, first theoretical solutions for one-dimensional (1D) problems of viscoelastic friction with a 1D viscoelastic foundation have been found. Then, the 1D model was extended to a two-dimensional (2D) model to find theoretical solutions for 2D problems of viscoelastic friction. Finally, the Method of Dimensionality Reduction (MDR) [2] has been applied to the theoretical solutions for the 1D problems to discuss three-dimensional (3D) problems of viscoelastic friction.

REFERENCES

1. Popov, V.L., 2018, *Is tribology approaching its golden age? Grand Challenges in Engineering Education and Tribological Research*. Front. Mech. Eng. 4:16.
2. Popov, V.L., Heß, M., 2015, *Method of Dimensionality Reduction in Contact Mechanics and Friction*, Springer, 253 p.