entropy 2021

Abstract

Walking down over the Spatiotemporal Scales in a Particular Nonequilibrium-Thermodynamics Dissipative Phenomenon Called Friction †

Adam Gadomski

Institute of Mathematics and Physics, UTP University of Science and Technology, Bydgoszcz, Poland

† Presented at the Entropy 2021: The Scientific Tool of the 21st Century, 5–7 May 2021; Available online: https://sciforum.net/conference/Entropy2021/.

Published: 5 May 2021

It is intriguing to fully comprehend whether the simple, macroscopic scale expressing Coulomb-Amontons law, describing the static friction effect, and referring to a ratio of friction force vs. the corresponding load, preserves when looking into more fine-grained surface (or, interface) dimensional scales [1]. This question is of utmost interest when attempting to comprehend the complex friction and lubrication phenomenon, expressing its relevance in bioinspired issues, pertaining to biomimetic solutions, represented by the natural articulating devices, such as articular cartilage, examined carefully in (sub)mesoscopic scales [2–4]. In what follows, a particular nonequilibrium-thermodynamics, dissipation addressing framework has been offered to unravel explicitly the spatiotemporal, and implicitly, force-field scales. It is based upon a dissipative autonomous ordinary-differential system, equipped with fractal-like kinetics, and fully immersed in the mesoscopic scale [4]. Its nanoscopic viz microscopic extension can be introduced either by means of certain anomalous diffusion vs. (mechanical) relaxation parametric sets, or when employing thoroughly molecular dynamics computer simulations [3]. A survey of adequately formulated experimental and computer simulation based long-perspective arguments has recently been proposed in [5]. The main idea of revealling the scale peculiarities touches upon certain assumption on the structure formation in the friction interlayer. The structure formation causes the suitable microscopic response of the soft-material, i.e., diffusion-relaxation involving propensity. A certain shortage of the method proposed points unavoidably to a lack of precise information about the involved force-field magnitudes, and their consecutive characteristics. Other studies do not show up such a drawback [6] but they do not deal in full and satisfactorily with the scale problem [1–4]. Our aim is to fill in the gap by proposing a scale-sensitive formulation of the friction-lubrication problem of importance for biolological systems, exemplifying by the articulating joints.

References

1. Gadomski, A. Multilevel-interaction friction procedure applicable in case of two opposing surfaces competing with one another – A gedanken experiment. *Phys. Essays* **2015**, *28*, 650–653.
2. Gadomski, A. On (sub)mesoscopic scale peculiarities of diffusion driven growth in an active matter confined space, and related (bio)material realizations. *Biosystems* **2019**, 176, 56–58.
3. Bełdowski, P.; Weber, P.; Dedinaite, A.; Claesson, P.; Gadomski, A. Physical crosslinking of hyaluronic acid in the presence of phospholipids in an aqueous nano-environment. *Soft Matter* **2018**, *14*, 8997–9004.
4. Gadomski, A.; Bełdowski, P.; Rubì, J.M.; Urbaniak, W.; Augé II, W.K.; Santamarìa-Holek, I.; Pawlak, Z. Some conceptual thoughts toward nanoscale oriented friction in a model of articular cartilage. *Math. Biosci.* **2013**, *244*, 188–200.
5. Dėdinaitė, A.; Wieland, F.; Bełdowski, P.; Claesson, P.M. Biolubrication synergy: Hyaluronan–Phospholipid interactionsat interfaces. *Adv. Colloid Interface Sci.* **2019**, *274*, 102050.

6. Seror, J.; Zhu, L.; Goldberg, R.; Day, A.J.; Klein, J. Supramolecular synergy in the boundary lubrication of synovial joints. *Nat. Commun.* 2015, *6*, 6497.

© 2021 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).