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Editorial

FOREWORD TO THE THEMATIC ISSUE: *WEAR PARTICLE TRANSPORT AND EMISSION: MECHANISMS AND ENVIRONMENTAL IMPLICATIONS*

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The papers of the present Special Issue as well as a number of papers of the subsequent Issues of Facta Universitatis – Series Mechanical Engineering represent extended versions of the research works presented at the International Workshop "Wear particle transport and emission: Mechanisms and environmental implications" which was carried out online from 24. to 25. February 2021. The workshop was a part of a series of tribological workshops that Prof. Popov (TU Berlin) and Prof. Ostermeyer (TU Braunschweig) organize annually since 2004, each year devoted to a chosen topical problem. The theme of this year's workshop is closely related to the "third body" problem in tribology [1]. To put it in a somewhat exaggerated way, the problem of the third body is the core problem of tribology and one of its greatest current challenges [2]. The third body is very closely related to all properties of a tribological system and determines the friction, the wear intensity, the chemical composition of the surface layers and the relevant system dynamics. Wear changes the surface topography, which in turn influences the frictional force [3]. The material transport from one contact partner to the other [4], [5] as well as the transport in the sliding plane [6] are of central importance for the tribology. This latter process ultimately leads to the emission of wear particles into the environment [7]. Especially in our time when people are actively concerned with their health, problems of the emission of abrasive particles, for example from brakes or car tires, are of great importance.

The connection and interrelation of friction, wear, and emissions were the core topics of the workshop. The problem of wear, of the third body and emissions from tribological systems are not only topical in scientific and political terms, but also highly complex. Only recently, promising approaches for adhesive wear [8], [9] have been proposed as elements of the whole complex process of "boundary layer machine" (Ostermeyer et al. [10]). A very important topic is measurement of emission, which is now approached also using new tools such as big data analysis. Since processes in tribological contact are difficult to access experimentally, numerical simulation methods play a special role here. Development of numerical concepts for fast numerical simulation of systems with geometric and material non-linearity as well as concepts for simulation of the "third body", mixing and surface modification belonged therefore to the central topics of the workshop too. While in recent years two important tools have been created with the method of dimensionality reduction [11] and the FFT-based boundary element method [12], which make it possible for the first time to simulate contact mechanics in their real complexity, there are so far no significant attempts to use these methods to simulate the third body. Obviously, there is above all an urgent need to search for new concepts for characterizing and understanding the third body.

Several adjacent topics related to mechanics of interfacial particles, mechanical and chemical processes in the surface layers, the influence of material structure, as well as basic questions of physics and modeling of relevant processes, including adhesion, have also been included in the discussion. On the other hand, a series of papers focused on engineering and medical applications have also been reported. Of course, the outlined field is too big to be dealt within a single workshop. Therefore, further meetings on this topic are needed in the future.

In the works presented at the workshop, the third body have been considered at very different scales. Thus, in the very first presentation by K. de Payrebrune, just a single macroscopic particle was considered. It was surprising how complicated and different can be the modes of movement of such a simple system. At the microscale and nanoscale, again single particles were in focus, e.g. in quasi-molecular dynamics simulations. At the mesoscale, the flow of particles was observed. But this flow underwent a self-organization (and self-healing). As a result, one could see again the rolls. It seems that the formation of rolls is a very common feature independently of material and scale. Their movement essentially determines the wear and the friction process. The studies of mechanics, evolution, and related physics of interfacial particles is an important current research topic.

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