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Ensuring everything runs smoothly in power plants and space shuttles: New project at the University of Bayreuth

In power engineering and space technology, the lubrication of moving machine elements is a particular challenge: the usual greases or oils have the disadvantage here that they evaporate in a vacuum and at high temperatures, while they lose their lubricating effect at very low temperatures. Therefore, solid lubricants are often needed. A new project at the University of Bayreuth aims to make a fundamental contribution to optimisation in this field, which has been little researched so far. Bayreuth's Engineering Design and CAD research group is cooperating with the Institute of Materials Engineering at the University of Kassel and the Computer Chemistry Centre at FAU Erlangen-Nuremberg.

The project, coordinated by Prof. Dr.-Ing. Stephan Tremmel, is associated with the priority programme SPP 2074 "Fluid-free lubrication systems with high mechanical loads" of the German Research Foundation (DFG). It will be funded with a total of around 780,000 euros over the next three years at the three locations. The University of Bayreuth will receive around 343,000 euros. The project is specifically about rolling bearings: these are bearings that contain an inner and an outer ring and serve, for example, to stabilise axles and drive shafts. Rolling bodies between the rings reduce the frictional resistance. Usually, oils or greases are used to lubricate bearings, but this type of lubrication is often disadvantageous or not possible at all for rolling bearings under extreme conditions. Such extreme conditions prevail in particular in a vacuum – for example in applications in energy technology or space technology. Under these conditions, liquid lubricants evaporate so that the lubrication fails. What is needed, therefore, are "dry" lubrication systems that work with solid substances.

The new project in Bayreuth, Erlangen and Kassel will deal with molybdenum disulphide (MoS_2), a solid lubricant that has been researched very little for rolling bearings under extreme conditions. "Compared to other solid lubricants that are being investigated in SPP 2074, molybdenum disulphide is characterised by the fact that it not only retains its lubricating effect at high temperatures of up to several hundred degrees Celsius, but also functions excellently in a vacuum in particular. The production as well as the coating of surfaces is cost-effective on an industrial scale. In our project, we want to gain fundamentally new insights into the optimal use of molybdenum disulphide as a lubricant. On this basis, it will be possible, for example, to increase the reliability of power plants or space vehicles," says Tremmel.

The focus of the planned research work is the development of a model that is capable of predicting the service life of MoS_2-lubricated rolling bearings with unprecedented precision. With this goal in mind, friction and wear processes will be analysed at different scales – from the nano to the micro to the macro scale – with experiments and computer simulations complementing each other. These cross-scale material analyses are made possible by the interdisciplinary network of competences from the fields of mechanical engineering, materials science and theoretical chemistry located at the three project sites. Modern methods of coating technology, material characterisation and material simulation will be used. The project will lead to fundamentally new insights into changed material structures caused by friction and wear. From this, in turn, important indications for the optimisation of solid lubricant coatings that can withstand extreme conditions will be derived.

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