Extract from the Annual Report 2022
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From research

Simulation of microparticles with PALADIN

In numerous types of application, small particles of differing origins are a problematic factor. This applies in particular to optical applications, in which foreign bodies can impair the optical coatings, but is also relevant in, for example, the field of room ventilation, where microparticles such as dust or aerosols need to be avoided. For this purpose, the Fraunhofer IST has developed the PALADIN simulation software, which numerically models the behavior of microparticles in variable geometries and different situations.

The software

The PALADIN (**P**lasm**A** **LA**ttice **D**ust **IN**tegrator) simulation software was developed in order to investigate the behavior of microparticles in different environments. The original use case was plasma coating equipment, in which particles can cause massive damage and, consequently, reduce production efficiency.

Through the simulation of such equipment with PALADIN, potential sources of danger can be identified and solution strategies can be devised. Furthermore, it is possible to test any hypothetical equipment configurations without having to actually build them. In addition to the geometry of the scenario, the required input parameters of PALADIN include, for example, the flow velocity and the density of the surrounding medium, as well as the starting conditions for the microparticles.

Utilization of PALADIN for optical coatings

One utilization example for the PALADIN software is the simulation of the EOSS® magnetron sputtering coating system. Figure 1 shows a result for PALADIN simulation runs in which a single particle flies back and forth between two targets and a substrate to be coated. It thereby becomes clear that when the particle is in close proximity to the substrate, it is charged particularly strongly by the local plasma and therefore accelerates more strongly. As a result, the risk of a collision with the substrate is increased – and thus the risk of damage.

Simulation of air flows by means of PALADIN

A further application example for PALADIN is the simulation of atmospheric air flows. In particular, the simulation of aerosols could be of considerable use in the future, as some viruses such as the corona virus are generally spread in this way. With PALADIN, it is possible to test the risk of infection in various scenarios on the basis of the existing air flows. Figures 2 and 3 depict exemplary simulations of such scenarios: Figure 2 shows the movement patterns of aerosol particles in an idealized hospital room with a ventilation unit, whilst Figure 3 shows an airflow in a pump.

Furthermore, PALADIN can be extended to other potential application purposes, such as for the simulation of particle dispersion within astronomical contexts.

The project

The PALADIN software was developed within the project "EVAPORE – Entstehungsdetektion und Vermeidungsstrategien von Mikropartikeln in Plasmabeschichtungsprozessen für die optische Industrie" (Origin-detection and avoidance strategies for microparticles in plasma coating processes for the optical industry). This is an IGF project (grant number 18590 N) of the Forschungsvereinigung Feinmechanik, Optik und Medizintechnik e. V. (Research association for precision mechanics, optics and medical technology).

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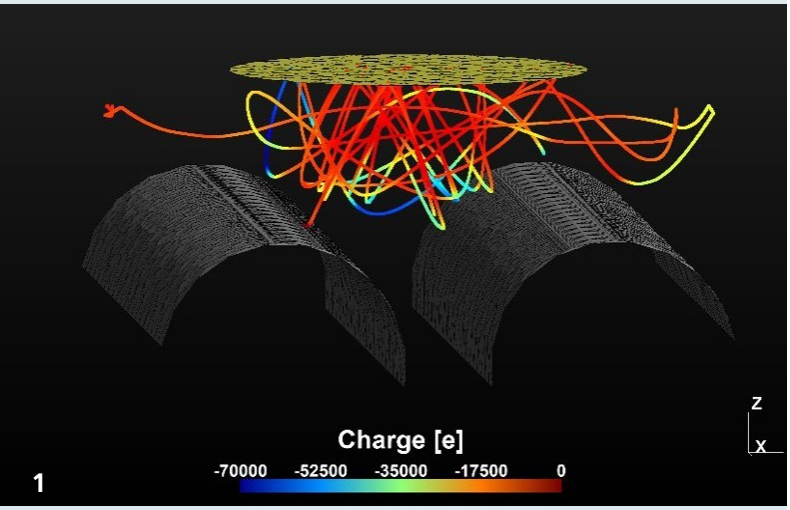
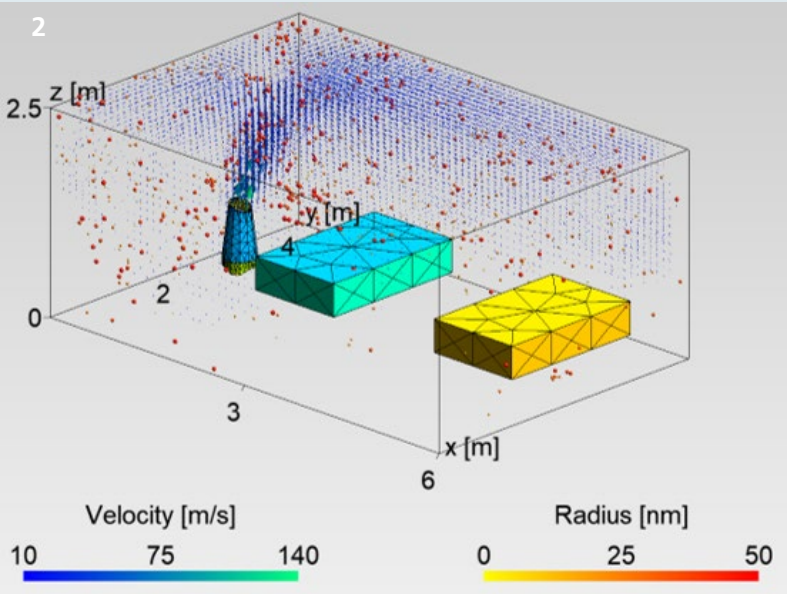


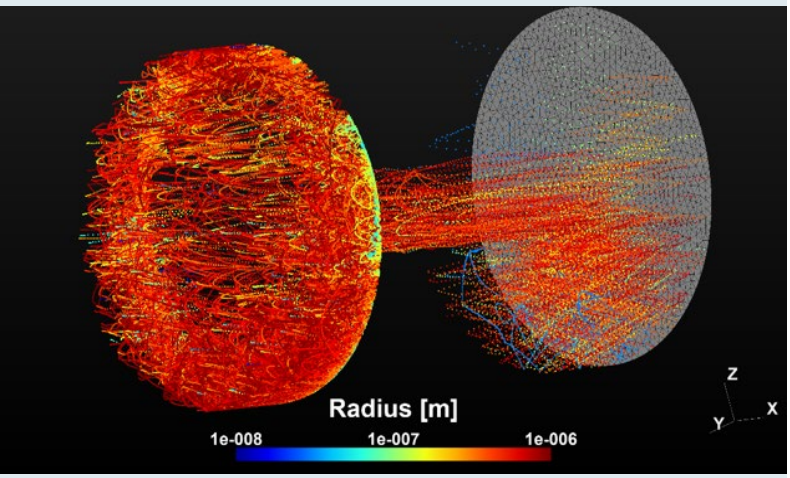
1

PALADIN-simulated path of a particle in the EOSS® system, with particle charge depicted in color.



2

Simulation of the movement of particles in a hospital room with ventilation system.



3

Simulated movements of particles of differing sizes in a pump.

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