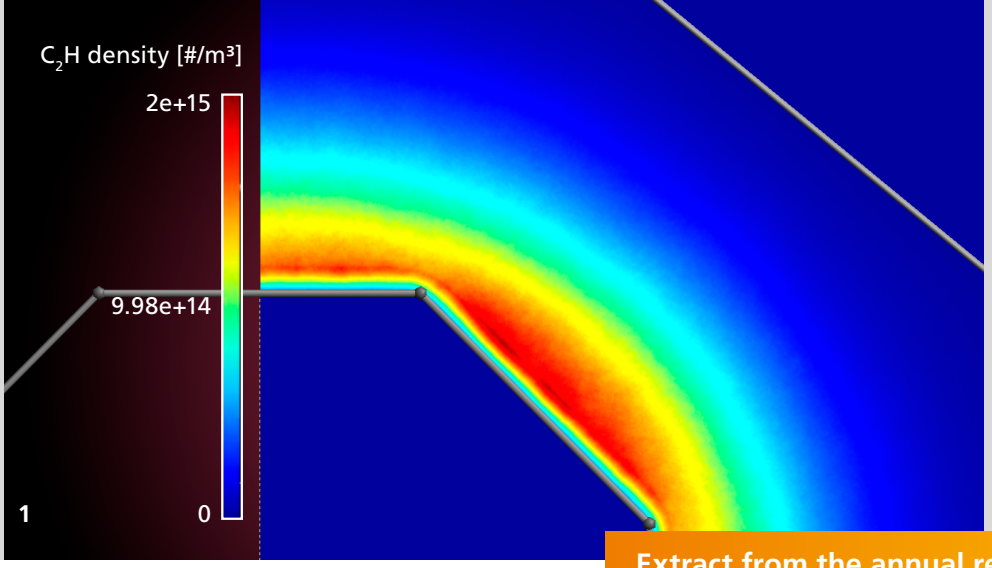

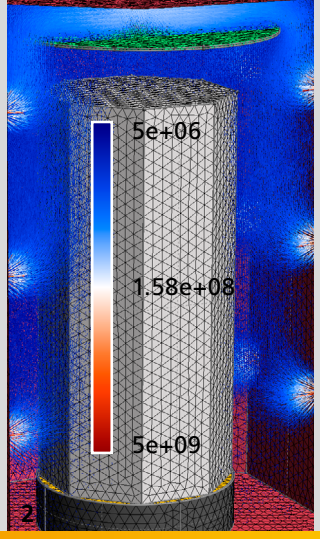

Extract from the annual report 2019
To the website: www.ist.fraunhofer.de/en.html

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

UPSCALING OF PECVD PROCESSES

Tribological hard-material coatings produced through PECVD processes (plasma enhanced chemical vapor deposition), in particular amorphous hydrocarbons (a-C:H or DLC, diamond-like carbon) are utilized in many technical applications. Their further proliferation and improvement, notably the enlargement of the coatable component surface, is limited however, by the complexity of the coating process. The Fraunhofer IST is therefore currently working on an in-situ ascertainment of the coating conditions in combination with a modeling of the process dynamics and layer formation, in order to enable a targeted scaling up of the process.

Amorphous hydrocarbon coatings protect against friction and wear

In many situations, DLC coatings are the method of choice for reducing friction and wear. With coefficients of friction close to those of polytetrafluoroethylene (Teflon®) and a hardness similar to that of ceramics, they are already frequently used today as a means of improving service life and increasing quality, for example in forming processes. In many cases, new processes are only made possible by DLC coatings, for example when the objective is to reduce or entirely avoid cooling lubricants in forming processes.

The challenge: Large and numerous components

DLC coatings are generally produced through PACVD processes. The vacuum plasma discharge used in this process has a complex physical behavior which, furthermore, depends strongly on the size and shape of the part to be coated. The larger and more complex the workpiece is shaped or the more small individual parts are to be coated, the more difficult it becomes to predict the necessary equipment settings in order to achieve sufficient coating homogeneity.

Larger component volumes in the form of large or numerous workpieces as well as an increasing complexity of coatable components are, however, required in order to expand the field of application and make the processes more economical. In order to overcome the resulting problem of scaling up, the Fraunhofer IST utilizes computer-aided simulation.

The solution approach: Modelling, process control and layer analysis

In the AiF Cornet project "DLCplus - Improved DLC coatings by more efficient process design", the Fraunhofer IST, in collaboration with the Université de Namur and the MateriaNova research facility in Mons, Belgium, is addressing this challenge.

By means of PIC-MC (Particle-in-cell – Monte Carlo), models of the layer-forming particle streams are created. The thereby resulting statements concerning the measurable, location-dependent plasma parameters, such as ion and neutral-particle current density and plasma potential, are verified in coating experiments using appropriate measurement technology.

The deep analysis of the actual plasma conditions on the component surface achieved in this way enables the targeted adjustment and improvement of the coatings. The feedback of the measured layer characteristics serves in turn as a means for improving the model and control variable for the coating process.

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1 *Simulation of the density of layer-forming gas particles.*

2 *Gas-flow simulation in a modeled coating chamber.*

3 *Fully equipped PACVD coating system.*

Outlook: More efficient process management through modeling and forecasting

The aim of the described work is to develop a process-control system that significantly advances the current status of technology. Reliable predictions of the coating result should be made possible. The results and future possibilities of the coating technologies will thereby be considerably improved and expanded. In this way, virtually all fields of the forming metal industry, automotive technology, and tool and fixture construction can benefit. Higher efficiency increases productivity and reliability and reduces costs. A deeper understanding of the coating process enables better optimization and exploitation of new coating situations.

The project

The described work receives funding for the promotion of an individual research project of joint industrial research from the German Federal Budget 2018, Section 09, Chapter 0901, Title 686 01, in the variant: CORNET (as part of a transnational CORNET overall project); IGF Project No: 230 EN.

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