Applied Research Activities

DLCplus – Improved DLC coatings by more efficient process design

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Diamond like carbon (DLC) coatings are a key technology in numerous technical applications such as automotive components, machine elements, cutting and forming tools. They are well known for their exceptional tribological properties such as low friction coefficient combined with high hardness and wear resistance. Common deposition methods for DLC coatings include physical vapor deposition (PVD), e.g. sputtering from a metallic sputter target with a precursor such as C_2H_2 as reactive gas and plasma-enhanced chemical vapor deposition (PECVD) with process gases such as CH_4 or C_2H_2. While those deposition techniques are already established in industry since several decades, it is still difficult to predict the deposition uniformity and intrinsic film properties for a given coater geometry including the arrangement of the substrates to be coated. As a result, every new substrate type and substrate arrangement requires a significant amount of iterative experimental optimization before the production can start.

For this reason, the Cornet project DLCplus aims to establish a predictive simulation tool for PVD, PECVD or hybrid PVD/PECVD deposition reactors for DLC coatings using C_2H_2 as precursor. It is a cooperation between three research institutes, namely Materia Nova, University of Namur and Fraunhofer IST and an accompanying industrial consortium. It combines experimental characterization with a multi-scale simulation approach for the reactor dynamics and atomistic film growth. Plasma discharges in C_2H_2 feature a large variety of hydrocarbon ion species and radicals with hundreds of potential reaction cycles. In order to keep the number of relevant plasma species as low as possible, DLCplus focusses on processes at low pressure, i.e. $p < 1$ Pa, which is the relevant process regime for hard DLC coatings.

This presentation gives an overview on the work in DLCplus including a simplified plasma-chemical reaction model, its application on various coating reactor geometries, atomistic film growth and process diagnostics. The outcome of the project can be used to perform gas flow and plasma simulations for industrial PVD/PECVD coaters or to provide simulation data that can be used for calibration or training of data-driven digital twins for DLC coating.

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