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Prediction of DLC layer properties by plasma simulation

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Hydrogenated amorphous carbon films (a-C:H) as a kind of diamond-like carbon (DLC) coatings combine unique optical, electrical and mechanical properties, resulting in numerous applications in different kinds of industries. These plasma coatings are continuously of high interest for research and industry because of the possibility to adjust the layer properties in wide scope by varying the deposition conditions like pressure, temperature or power. DLC films are widely used in the automotive industry due to their unique tribological properties, especially as an enabler for modern fuel injection equipment. One important goal of a modern flexible industrial production especially for automotive mass production must be the control of properties regardless of the kind of plasma deposition system, e.g. chamber size or loading density. The combination of plasma simulation, coating experiments and plasma diagnostics enables the monitored deposition of hydrogenated amorphous carbon films.

The study will present a global model for acetylene and argon plasmas to support the process development for the deposition of a-C:H films. With this simulation it is possible to calculate all partial pressures of reaction products, relevant plasma parameters and particle fluxes. The functionality of the global model was validated with plasma diagnostics by measuring plasma parameters and comparing them with simulated results. The use of the presented global model allows it to reduce the influence of all adjustable machine parameters (e.g. bias voltage, gas flow, …) to only one main virtual parameter influencing the coating properties: the energy per deposited carbon atom. The influence of this parameter on relevant coating properties, e.g. indentation hardness or hydrogen content will be demonstrated. As a result, in the future it will be possible to adjust the required coating properties independently of machine parameters without a sophisticated design of experiments.

Keywords
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