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Deposition and Properties of DLC, Si-DLC, Me-DLC Coatings and DLC based Nanolayer Systems

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DLC coatings are characterized by high hardness, high wear resistance and low friction coefficients. The demand to further reduce friction and wear in the automobile sector in order to achieve a reduction in fuel consumption and CO_2 emission is the driver for the application of the DLC coatings in this most important field of applications. In the automotive powertrain DLC coatings are used to compensate friction and wear on engine components. In order to allow higher specific loads and/or temperatures on coated automotive engine parts the properties of the DLC coatings have to be further improved. DLC coatings have a long history since the 1950s and later in the 1980s the magnetron sputter technique was used to deposit DLC followed by DLC deposition including a DC magnetron cathode opposed by a biased substrate carrier. Magnetron deposition of W-DLC (a-C:H:W) with plasma assistance for a high volume substrate loading at industrial scale conditions using a plasma-booster arrangement was reported in the 1990s. Using similar, optimized magnetron based technique, recently DLC (a-C:H), Si-DLC (a-C:H:Si), Me-DLC (a-C:H:Me) coatings and nanolayer systems based on these single phase coatings were deposited and characterized. The properties of DLC coatings and Si-DLC based coatings are shown as a function of the hydrogen concentration in the coatings. Raman spectroscopic investigations have been made and properties of DLC, Si-DLC and Me-DLC are presented. The highest indentation hardness of > 40 GPa and lowest abrasive wear rates of 0.6×10^{-15} $m^3/(Nm)$ were found for DLC. For the Si-DLC coatings the lowest friction coefficient of 0.06 and highest temperature stability up to 500°C were achieved. With the Me-DLC the best toughness and high surface energy were observed. Using layer combinations of these DLC types nanolayer systems with coating properties which reflect combined and/or advanced layer properties resulting from direct interaction of individual layer materials were deposited. DLC coatings and DLC based nanolayer coatings offer exceptional conditions for present and future industrial applications.

Keywords
DLC
Magnetron