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Microstructure and surface properties of Cr-DLC films deposited by MF magnetron sputtering enhanced by hollow cathode arc

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Diamond-like carbon (DLC) films possesses excellent properties including high hardness, low friction coefficient and chemical inertness, etc. The main reason of the retarding industrial applications of DLC as tribological coatings is their disappointing adhesion caused by relatively high compressive stresses in the range of some GPa. Me-DLC has proven to be one kind of carbon based films which is featured by lower compressive stresses and excellent tribological performance. In this study, hollow cathode enhanced MF magnetron sputtering was used to prepare Cr-DLC on HSS.The influence of high-density plasma during both surface cleaning and DLC deposition stages on surface morphology of films, microstructure, adhesion between the substrate and films, and tribological properties was focused on. The arc current was set as 0A, 15A, 20A, 25A, 30A, respectively and the distance between the target and substrate was set as 100mm. The experimental results have demonstrated that higher plasma density originated from hollow cathode arc in the cleaning step substantially improve the adhesion between the films and substrate. The adhesion force class may increase to HF1 - HF2 from HF5 - 6 if the hollow cathode arc current of 30A is utilized. The film surfaces become smoother and the microstructure get denser at higher arc current. The Raman data show that ID/IG decreases with the arc current increasing, which reflects an increase of sp3 content in the film. Higher micro-hardness and lower friction coefficient of the DLC films has also been achieved, leading to a better tribological properties.

Keywords
Hollow cathode arc
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Microstructure