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## **Influence of the compound layer composition of steel to the adhesion of DLC films**

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DLC films have special properties, which are of great interest in fields of tribology, including the high hardness and the low coefficient of friction. These properties are limited because of shortcomings in adhesion of DLC films on steel. So far, metallic adhesive layers like titanium and chromium are established options for the improvement of the adhesion of DLC films on steel. Past investigations show that plasma nitriding of the surface can strongly improve the adhesion.

Starting point is the overview of the different surface modifications, which can occur through plasma nitriding and how they influence the adhesion of DLC films. The surface can consist of a compound layer of  $\gamma'$ -nitride and/or  $\epsilon$ -nitride or it is also possible that there is no compound layer. These surface modifications differ in their composition, crystal structure, bond type, as well as their solubility and diffusion velocity of carbon. One hypothesis is that the carbon solubility has a significant influence on the adhesion of DLC films. First, the influence of nitriding parameters to the compound layer composition was analysed. After investigation of the surface composition by XRD it is concluded that the temperature (ranged between 480 °C and 560 °C), gas composition (ranged between 10 % and 80% N<sub>2</sub>) and pulse-pause ratio (ranged between 1:3 and 1:7) seem to be factors with great influence on the composition of the compound layer.

By means of a two-stage nitriding process it was ensured, that the hardness depth profile of all three surface modifications were similar. Thus, the "eggshell" effect should have no significant influence on the adhesion differences between the surface modifications and can be ignored. Further, the influence of the surface composition on the adhesion behaviour was analysed. For these purposes, the nitrided specimens were DLC coated by PACVD. First tests, executed on a scratch test rig, indicate that there is a correlation between compound layer composition and adhesion properties. The LC2 value of the  $\epsilon$ -nitride surface was 41 N,  $\gamma'$ -nitride 19 N and without compound layer 30 N. Typical values of LC2 DLC films with metallic adhesive layers are about 25 N.

### **Keywords**

surface modification