Hard protective thin films on soft flexible elastomers: Ideas about tentative solutions

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In this lecture at the University of Belgrade I will concentrate on a simple but challenging question: how to protect an elastomer, like rubber, with a protective thin hard film while keeping the substrate flexible? It sounds as a typical engineering question but it bears many fundamental concepts from materials physics. Elastomers are materials that suffer from severe wear and cause high friction losses when subjected to dynamic contact, which often causes failure of devices. Elastomers are used in many applications in daily life, ranging from rubber seals, windscreen and windshield wipers to flexible electronics.

Our basic idea is protecting elastomers by the deposition of diamond-like carbon thin films, either with or without nano-sized particles. To accomplish that objective, an integral approach is discussed in this presentation, i.e. finding correlations between deposition conditions, microstructure characterization of the films and adhesive performance.

The deposition is performed by using plasma assisted chemical vapor deposition, which is fine tuned to obtain a tailored microstructure of the films. The trick turned out to be generating a columnar tile-like structure on top of the flexible substrate, and indeed excellent frictional and wear performance were obtained.

It is important to realize that rubber/elastomers are not elastic but viscoelastic. In particular these viscoelastic properties of the substrate play a decisive role in the frictional performance of the DLC-elastomer materials systems and devices. As a consequence the frictional behavior of DLC-coated elastomers was analyzed in detail with the aid of theoretical evaluations confronted to dedicated microscopy experiments.

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