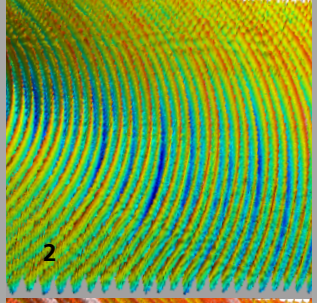

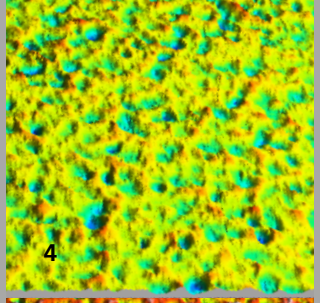

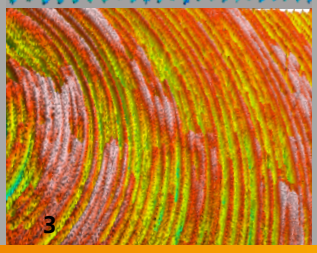

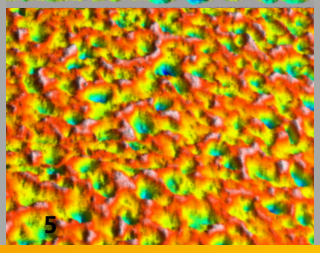

Extract from the annual report 2016
To the website: www.ist.fraunhofer.de/en.html

STRUCTURE-PRESERVING HARD COATINGS

The structure of the surface plays an important role in hot forming processes such as forging. In the case of unstructured surfaces high tribological loads usually occur during the forming process, leading to severe loss of material. Frictional forces between the die surface and the forging are to be reduced by the use of lubricants. An additional structuring of the surface here not only ensures improved adhesion of lubricants but also a reduction in contact ratios. The surface must, however, be protected as effectively as possible against the leveling mechanisms caused by plastic or abrasive wear in the tribological contact. The conditions for an optimum design of the die surface and its successful preservation could now be defined at the Fraunhofer IST.

Topography and wear development

In a first step, different machining methods for die production – partly in combination with cost-effective abrasive blasting processes – were investigated with regard to their wear behavior. In serial forging tests the wear rate could be determined by tactile measurements of the die surfaces. With the aid of the Abbott-Firestone curve, three-dimensional surface characteristics, such as the arithmetical mean roughness S_a, were determined for the purpose of evaluation. The tests showed that, particularly in the case of tribologically highly loaded dies, there were significant correlations between the surface structure and wear development.

Successful preservation with plasma technologies

To secure retention of the specified structures a so-called duplex treatment of the dies was carried out in which the surfaces are first of all treated by plasma nitriding and then provided with a hard coating. In this way the hardness of the outer layer and of the surface could be increased and concurrently the heat resistance of the substrate. These properties influence the resistance to plastic deformation and to a great extent abrasive wear resistance as well. Investigations also revealed that the surface structure most resistant to predominantly tribological stress also has the lowest wear values. This topography could be set to an arithmetical mean roughness of S_a = 1.5 µm by abrasive blasting and has optimum properties for the adhesion of water-based graphite lubricant films. High frictional forces during forming and the abrasive wear thereby promoted can thus be significantly reduced by targeted surface conditioning. At the same time, this surface has sufficient load-bearing capacity not to be leveled by high surface pressures. The duplex treatment of the dies additionally supports this.

Industrial benefits

In order to evaluate the wear behavior observed in serial forging tests on model dies under industrial production conditions as well, a project partner's forging dies were processed by the wear protection method developed. Industrial dies were structured and given a combined duplex treatment consisting of plasma nitriding and the PECVD deposition of a hard coating. Despite typical fluctuations in the die service lives,

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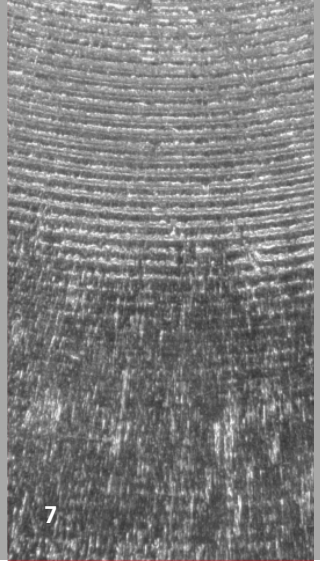

the modification yielded positive benefits. Compared to the series production dies, which have only been gas nitrided, the modified dies showed marked improvements in abrasive wear, especially in tribologically highly loaded areas. Furthermore, an increase in service life was achieved as a result of a considerable decrease in mechanically induced cracks.

Outlook

In tribologically highly loaded forging dies improved wear behavior and the associated increase in service life are currently still opposed by the increased expense of surface conditioning by the preservative duplex treatment. For this approach to be a viable alternative even as regards its cost-effectiveness, the service life of the modified dies must be significantly increased by the coating. Results, which have so far been promising, must in future be confirmed by further trials.

1 - 5 *Tribologically loaded dies with different topographies (2) hard and (3) soft turned or (4) medium and (5) coarsely blasted.*

6 - 7 *The turned surface after 100 forging cycles shows (6) strongly abrasive wear marks in the untreated state and (7) preservation of the topography in the duplex-treated state.*

CONTACT

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