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Correlation between thermal conductivity and wetting behavior of diamond-like carbon coatings on elasto-hydrodynamic friction

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Sustainable lowering of greenhouse gas emissions is one of the main drivers for research and development in the automotive sector. Minimization of frictional losses of highly loaded rolling-sliding contacts in automobile gearboxes by diamond-like carbon (DLC) coatings offers high potential in terms of efficiency improvement. Recent works using a gear efficiency test-rig revealed that the DLC coating ZrC_g (a-C:H:ZrC_g) deposited on gears contributes not only to friction reduction under boundary and mixed friction conditions but also reduces the coefficient of friction under elasto- hydrodynamic lubrication (EHL) by maximum 39% compared to uncoated gears. In this work, two different approaches were pursued to explain this yet barely known effect of DLC coatings under EHL conditions considering the thermal conductivity and the wetting behavior of the coatings. The investigations were based on four different gear oils - mineral oil (MIN), polyalphaolefin (PAO), polyethylene (PE) and polyglycol (PG) – and different a□C:H:Zr_xC_{1-x} coatings deposited by direct current magnetron sputtering. Coefficients of friction in fluid film lubrication were measured at the FZG twin disc test-rig. Thermal conductivity was determined by means of laser flash method at temperatures T=40°C and T=100°C. The wetting behavior was analyzed determining interfacial tension and surface energy of the DLC coatings and the gear oils by means of contact angle measurements. The results from fluid coefficient of friction calculations as well as from contact angle measurements were correlated to the frictional behavior of rolling-sliding contacts under EHL conditions using the gear oils at T=40 °C und T=100 °C. Finally, Chemical interactions between the DLC coated discs and the gear oils were investigated by Raman spectroscopy and X-ray photoelectron spectroscopy.

Keywords
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