1 Introduction

More than 51 million vehicles with an annual total mileage of about 699 billion kilometres are registered in Germany [DES12, UMW12]. Assuming an average consumption of 7.5 l per 100 km, a reduction in fuel consumption of 1% to 3% would lead to savings of 524 to 1,573 million litres of fuel [UMW12]. Efforts to reduce fuel consumption encompass a variety of measures, from reducing the vehicle weight to increasing its power density, nominal speed and maximum mean effective pressure. Power densities of contemporary diesel and gasoline engine designs range from 30 kW/dm^3 to 105 kW/dm^3 for charged gasoline engines [SCH11]. However, an increase in the specific power density is accompanied by an increase in the thermo-mechanical stress of the piston group (piston, piston rings and liner): Higher blow-by losses, wear as well as entry of oil into the combustion chamber are the undesirable side effects. In this connection, the piston group is responsible for up to 50% of the total mechanical losses of an engine, in particular for higher specific loads [DEU10]. As a reaction towards these continuously increasing thermo-mechanical stresses, various approaches to tribological optimisation of surfaces have already been pursued, especially in the area of cylinder liners. In addition to specific material systems and honing methods, micro-dimples cut into a surface have been providing, for some time now, a viable alternative approach to improve friction and wear properties as well as to reduce oil consumption.

The effect and the tribological potential of such microstructures were fundamentally investigated within the interdisciplinary DFG research group 576. Based on a wide range of experiences, the primary objective was to make the tribological behaviour of thermo-mechanically highly stressed surfaces far superior to conventional surfaces by a distinct creation of microstructures. During the six-year duration of the project (2006 to 2012), scientists at the Leibniz Universität Hannover and the Universität Kassel from the disciplines of tribology, production and measurement technology worked closely together (see Figure 1-1). Their collaboration provided fundamental insights concerning the simulation-based design of stochastically and deterministically structured surfaces (subproject 1). Stochastic surface structuring was realised by porous, thermally sprayed coatings, whereas deterministic surface structuring by the cutting of micro-dimples into a surface (subprojects 2 and 3). Innovative optical measuring strategies were developed to measure the produced microstructures (subproject 4). Based on extensive experiments, the tribological potential of microstructures for different contact conditions, load collectives, and demonstrators were investigated, and the tribological correlations were systematically elaborated (subprojects 1, 2 and 3). Furthermore, a transfer of the research results in an industrial application was realised by the microstructuring of industrially manufactured cylinder liners. The experimental investigation of those machined liners was carried out on a heavy duty diesel single cylinder test engine (subproject 5).

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