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Use of DLC-Coatings to Reduce Friction in the Powertrain of Passenger Cars

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In 2009 the average CO_2-emissions of newly registered passenger vehicles in Germany was 154.2 g/km, i.e. 6.4 % less than in 2008 and about 20 % less than in 1998. According to the latest regulations of the EU-commission the CO2 target for cars will be reduced to 95 g/km by 2020.
Such a significant reduction of the CO_2-emissions can only be achieved by a concerted effort of the automobile industry, and presupposes the introduction of new concepts such as battery electric vehicles, fuel cell technologies and hydrogen or natural gas powered vehicles. However, the internal combustion engine will still play an important role during the foreseeable future, so that a continual improvement of components for conventional vehicles remains an important priority. Functional improvements such as the start-stop system and brake energy regeneration are examples of new technologies recently introduced. An alternative approach to reducing fuel consumption is to minimize friction in the power train, especially as many components will also find usage in future vehicle concepts.
DLC-coatings represent one of the most interesting possibilities to reduce friction and wear of engine components. As testing of engine components is quite expensive, screening of suitable coatings is usually carried out using a ball on disc tribometer e.g. a SRV. The coefficient of friction (COF) of DLC-coated components is considerably lower than for uncoated components under conditions of dry lubrication. Typically, a COF of ca. 0.1 can be obtained for a DLC-coated surface and a steel counterpart without lubrication. This corresponds to the friction for a steel-steel system using conventional oil lubrication. If such a lubricant is used in a DLC-coated system, only a moderate reduction in friction can be observed, as the additives used in the lubricants have been optimized for standard steel surfaces over the last decades.
Recently, extremely low COFs have been published for certain DLC-coatings in combination with modified lubricants. COFs below 0.01 have been observed and are attributed to so called super low friction or super lubricity. This effect could play an important role in the reduction of fuel consumption, if it can be transferred to vehicle applications.

Keywords
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