Carbon nanostructures as lubricant additives – the effect of surface functionalization

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In recent years, increased environmental concern and regulations have fueled a search for new lubricant additives with reduced environmental impact. Owing to their attractive properties, carbon nanostructures have been proposed as potential candidates for a new generation of friction-modifying and antiwear additives. This broad family of nanoparticles can exhibit widely varying dimensionality and structural morphology, as well as mechanical and chemical properties. Moreover, their excellent properties as carrier materials combined with the rich and well-established chemistry of carbon offer endless opportunities for surface functionalization and tailoring of additive properties.

While the primary purpose of functionalization for a long time has been to enhance the dispersibility of nanoadditives in the base lubricant, the extensive research on the topic in later years has led to the identification of several additional benefits of surface modification. For example, surface modification is inevitably accompanied by a change in the nanoparticle's ability to interact with its surrounding environment, most often in the form of reduced chemical inertness and increased chemical reactivity. Consequently, through considerate selection of functional groups, it might be possible to synthesize carbon-based nanoadditives with tailored adsorption and wetting characteristics, as well as tribochemical reactivity, that can improve the tribological performance of the lubricant beyond the contribution of the carbon nanostructure alone. Another interesting approach for improving the performance of carbon-based friction-modifying and antiwear additives involves combining nanostructures of different dimensionality to obtain a hybrid nanostructure that can make use of the characteristic lubrication mechanisms of both its components. Furthermore, by utilizing their excellent properties as carrier materials, it might be possible to functionalize carbon nanostructures with functional moieties that provide additional additive properties (e.g., antioxidant properties), which would be an important step towards deliberate development of multifunctional additives. With greater understanding of the underlying lubrication mechanisms of carbon nanostructures, these findings could potentially be exploited to develop the lubricant additives of the future.

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