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Friction-induced transfer of carbon quantum dots on the interface: Microscopic and spectroscopic studies on the role of inorganic–organic hybrid nanoparticles as multifunctional additive for enhanced lubrication

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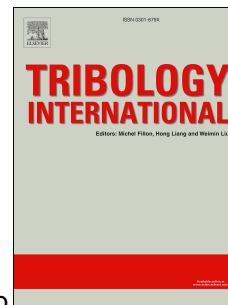
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**Friction-induced transfer of carbon quantum dots on the interface:  
Microscopic and spectroscopic studies on the role of  
inorganic–organic hybrid nanoparticles as multifunctional additive  
for enhanced lubrication**

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**Abstract**

Inorganic–organic hybrid carbon quantum dots (CQDs) attached the structure of diphenylamine (DPA) on the surfaces (CQDs<sub>N</sub>) have been successfully prepared by one-step pyrolysis method at lower temperature. The obtained N-doped carbon dots (CQDs<sub>N</sub>) were spherical particles with a narrow size distribution exhibiting excitation-dependent nature, which are also proved to be an multifunctional additive exhibiting not only antioxidant but also antiwear and friction-reducing performances. Even tested under higher load, CQDs<sub>N</sub> still exhibited superior friction-reducing performance till now in polyethylene glycol (PEG) for steel/steel pairs. The function of CQDs<sub>N</sub> with polar nature, acting as bearing balls and depositing on the interface to form non-uniform protective film, might account for the excellent antiwear and friction-reducing performances under boundary lubrication.

**Keywords:** Inorganic–organic hybrid carbon quantum dots; contact interfaces; antioxidant; lubrication mechanism.

**1. Introduction**

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