# Technical Achievements and New Potential Risk: Studies on Particulate Matter of Low-emission Diesel Engine*

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Soot particles in the exhaust of diesel engines are increasingly criticized for being a potential risk to the public health and for being a serious threat to air quality. The development of low-emission diesel engines is a key solution to reduce the emission of particulate matter. We have studied the microstructure of low-emission diesel engine soot particles by means of high-resolution transmission electron microscopy. The tested low-emission diesel engine is developed to fulfill the Euro IV standard for heavy-duty diesel engine. The particles collected indicate a change in the microstructure (Fig. 1) and therefore a change in the soot formation mechanism under low-emission conditions. Our studies[1,2,3,4] reveal that engine-internal measures targeted to minimize soot emissions from modern diesel engines and focused on the reduction of carbon mass are not automatically beneficial for human health. As soot from the

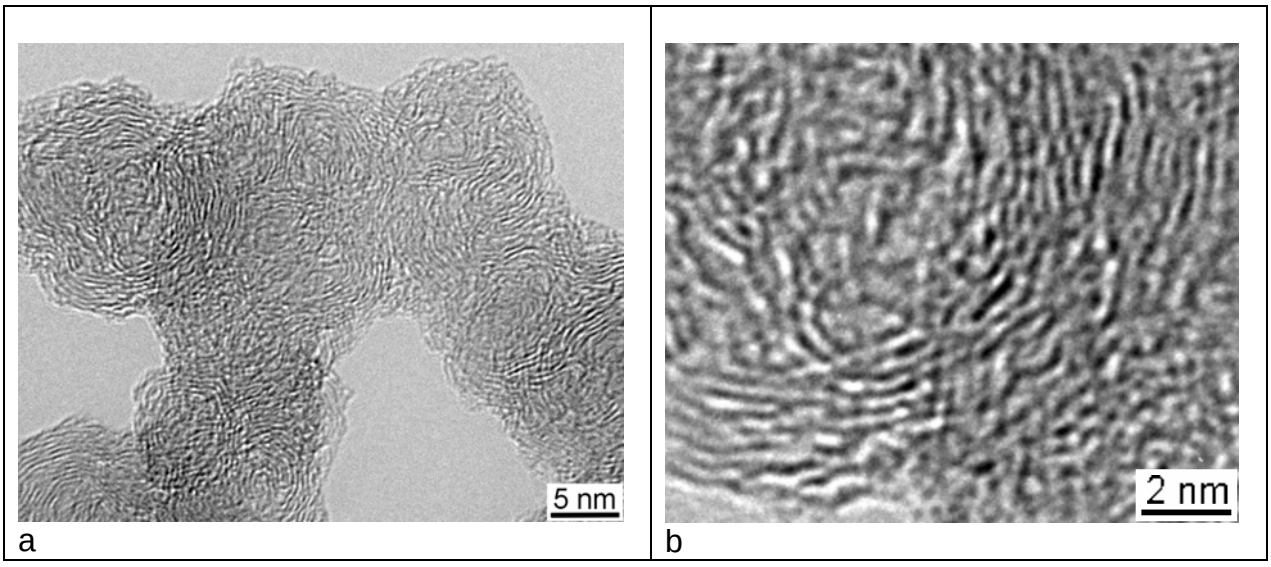


Fig. 1 a) Electron micrograph of soot emitted from Euro-IV diesel engine; the size of primary particles is smaller than that of older diesel engine[1]. b) High-resolution image revealing the microstructure of a primary particle of Euro IV soot. The low-emission diesel engine emits particles with defective structure and surface. The graphene layers are strongly bent and exhibit a high content of $sp^3$ hybridized carbon[4].

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high-performance engines becomes smaller in size and carries more functional groups, it becomes more bio-available, resulting in facile interfacing between the inorganic soot and the biosphere. This new potential risk stands opposed to the fact that, due to the same microstructural features, the low-emission engine soot is more reactive (Fig.2) and can be more easily burnt if suitable filtering techniques are applied[5]. However, the development of filtering technology must be directed to the removal of ultrasmall particles which may pose a higher risk per gram to the biosphere than more conventional forms of large-particle soot.

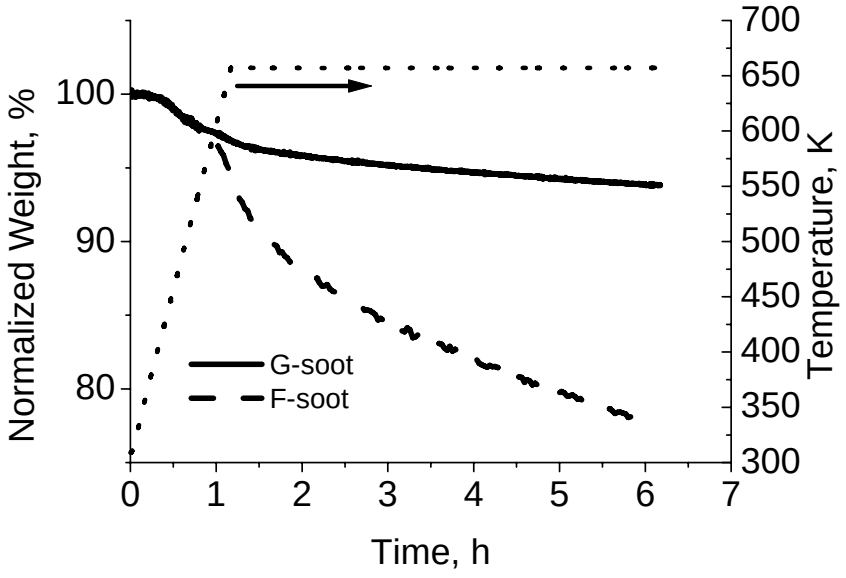


Fig.2 Isothermal oxidation of soot samples at 653 K in 5% oxygen in helium. The Euro IV soot (labelled as F-soot) shows higher oxidation rate than that of soot of the older engine (labelled as G-soot)[1]. Also the on-set combustion temperature of Euro IV soot is 200 K lower than that for soot of the older engine.

**Reference:**

1: D.S. Su, J.-O Müller, R. Jentoft, D. Rothe, E. Jacob, R. Schlögl, *Topics in Catalysis*, 30/31, 241 (2004)
2: D.S. Su, R.E. Jentoft, J.-O. Müller, C. Simpson, K. Müllen, A. Messerer, R. Nießner, R. Schlögl, *Catalysis Today* 90, No. 1-2, 127 (2004)
3: J.-O. Müller, D.S. Su, R. Fentoft, J. Kröhnert, F. Jentoft, R. Schlögl, *Catalysis Today* 102-103, 259 (2005)
4: J.-O Müller, D.S. Su, R. E. Jentoft, U. Wild, R. Schlögl, *Env. Science and Technology*, in press
5: E. Jacob, N. D'Alfonso, A. Döring, S. Reisch, D. Rothe, R. Brück, P. Treiber, H.P. Lenz (Hrsg.) 23. Internationales Wiener Motorensymposium, 25.-26. April 2002, Band 2: Fortschritt-Berichte VDI Reihe 12 Nr. 490 Düsseldorf: VDI-Verlag 2002, S. 196-216