SOOT DEPOSITION IN LUNGS OF MICE

A. M. Baklanov[1*], V.V. Karasev[1], A.A. Onischuk[1], A.N. Sergeev[2], A.S. Safatov[2], O. P'iankov[2], E.I. Riapchikova[2], B.N. Zaitsev[2], A.S. Toporkov[2]

Institute of Chemical Kinetics and Combustion SB RAS,
630090, Novosibirsk, Russia[1].
State Research Center of Virology and Biotechnology “Vector”, Koltsovo, Novosibirsk Region, Russia, 630559, Russia[2]

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Soot formation under combustion of hydrocarbon fuels can create a considerable ecology problem. It is enough to say that combustion process results in generation of toxic, mutagenic and carcinogenic products which can condense to the surface of soot particles. Most often soot is emitted to the atmosphere as aerosol aggregates composed of small primary particles. Morphology of the aggregates is a crucial factor which determines the transport of soot in the atmosphere, efficiency to penetrate to lungs of human and animals, and the aggregate surface area able to adsorb harmful species. Thus, for example, it is well known that soot can be formed both as compact and chain-like aggregates. However, the aerodynamic size of chain-like aggregates is considerably less than that for compact aggregates of equal mass composed of the same primary particles. Meanwhile the surface area for the chain-like aggregates can be even larger than for compact structures. In other words, chain-like aggregates seems to be more dangerous than compact ones.
Thus, it is important to investigate factors which determine soot aggregate morphology and find correlation between these factors and efficiency to deposit in lungs. This work is aimed to the morphology of soot aggregates formed under pyrolysis of benzene and deposition of these aggregates in the lung of mice.
Soot generator was constructed as a flow reactor heated up to the temperature 1370 K. Benzene vapors mixed with nitrogen were supplied to the inlet of reactor. The total pressure in the reactor was 1 atm. At the outlet we observed soot formed due to the thermal decomposition in the reaction zone. Transmission Electron Microscopy analysis showed that soot is formed as chain-like aggregates, composed by small primary particles (Fig. 1).
One of the reasons for the formation of chain-like structures can be Coulomb interactions between coagulating soot particles. To verify this assumption an imaging system was used to measure an electric charge of soot aggregates. Soot was injected to an optical cell. The beam He-Ne laser passed through this cell. The scattered light from was detected by a CCD camera. It was possible to observe aggregates of size > 0.2 μm. The movement of aggregates in the presence of a homogeneous electric field gave an information on the electric charge of the aggregates (Fig. 2). About 50% of aggregates was positive and other 50% - negative. Typical charge of aggregates was about 10 elementary units.
Thus, one of the soot harmful impacts to the health of human beings and animals arises from the fact that chain-like aggregates penetrate and deposit more easily to lungs than compact aggregates. Another serious problem is caused by the aggregation of charged particles in lungs which makes it difficult to put out the aggregates from lungs. Fig. 3 demonstrates soot aggregates in lung of mouse after breathing the air with soot (number concentration 10^5 cm^{-3}.

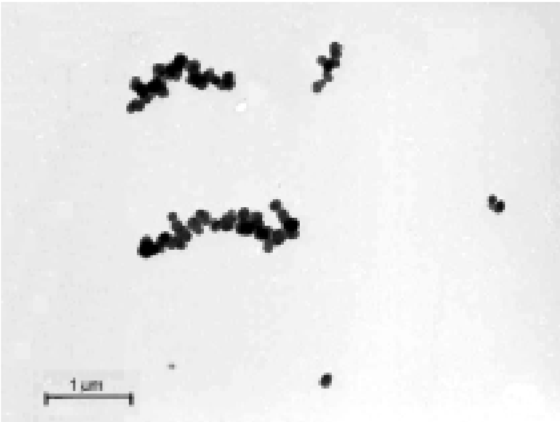

Fig.1. TEM image of soot aggregates

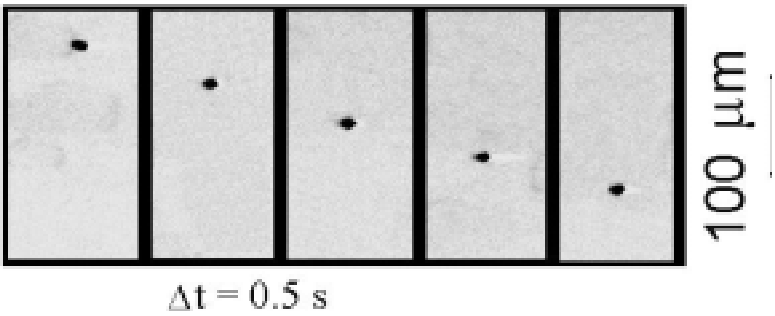

Fig. 2. Imaging system data illustrating soot aggregate movement in a homogeneous electric field. Time is increasing from left to rights. Time interval between frames is 0.5 s. Movement downwards corresponds to the positive charge.

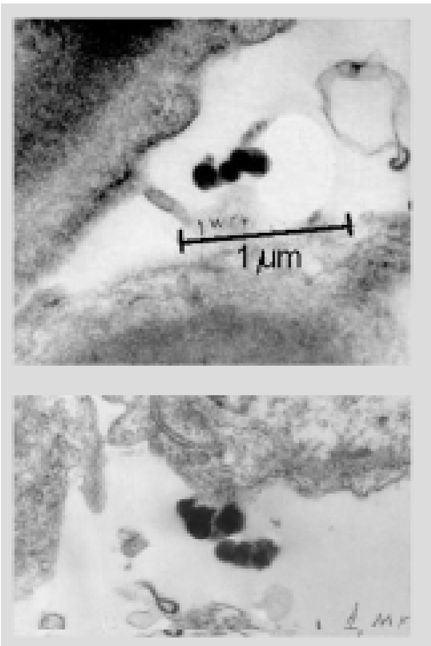

Fig. 3. TEM images of soot aggregates in lungs of mouse