TRIBOEMISSION OF NANOPARTICLE AEROSOLS

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ABSTRACT
In recent decades, important efforts have been made to reduce the concentration of several contaminants in the air. Abrasion of materials including breaks, solid lubricants, and construction materials during their machining, demolition or normal wear is one of the major non-exhaust sources of aerosol emissions. A large volume of experimental research has been focused on measuring concentration time series, size distribution, and morphological and chemical analysis of aerosol particles. However, only few studies were centred on quantifying the emission kinetics [1].

Recently we developed a new method and two experimental setups to measure kinetic and aerodynamic parameters of aerosols generated due to abrasion of solids under well-controlled conditions. The first setup with a pin-on-disk configuration allows measuring the emissivity of nanoparticle aerosols under sliding on laboratory scale [2]. The second one – Temis 1000 – is a mid-scale simulator of tire-pavement abrasion under pure rolling, pure sliding or combined rolling-sliding [3].

The method of quantification of emission rate consists of the following steps:

1) Determination of the rate of air interchange in the aerosol-proof chamber with the surrounding atmosphere.
2) Measuring the concentration time series of nano- and microparticle aerosols in the range 10 nm – 10 µm using 26 bins during abrasion and the transition decay of the concentration after the end of the test.
3) Determination of the time constants of transitional concentration decay for each bin corresponding to different aerodynamic particle diameters.
4) Calculation of the emission rates using the model of mass-balance.

The developed method was applied for characterization of a broad range of materials including composite polymeric top-of-rail friction modifiers, ceramics, nanofunctionalized cementitious composites, and so on. In most cases the nanoadditives introduced into the composite matrix were not liberated as free aerosol particles. The effect of nanoadditives mainly related to the modification of the matrix properties and its wear resistance.

Analysis of kinetics and size distribution of aerosol particles was also useful to investigate into the basic mechanisms underlying wearing of hard solids such as oxide ceramics under mild rubbing conditions.

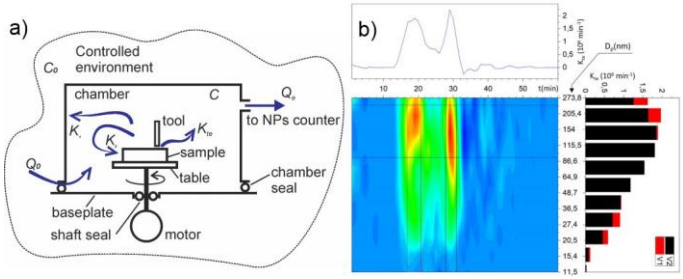

Fig.1 a) Schematic drawing of the experimental setup; b) emission rate of aerosols from Al_2O_3-Al_2O_3 abrasion.

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