Publications of the Institute of Geophysics, Polish Academy of Sciences
Geophysical Data Bases, Processing and Instrumentation
vol. 423 (C-112), 2018, pp. 39-40
DOI: 10.25171/InstGeoph_PAS_Publs-2018-021
16th Castle Meeting New Trends on Paleo, Rock and Environmental Magnetism, Chęciny, Poland, 2018

Magnetic Properties of Brake Wear Emissions – Preliminary Results

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Abstract

Airborne pollution poses a serious threat to human life due to its associations with a variety of health issues, including damage to not only respiratory and cardiovascular health, but also neurodevelopment and cognitive functions. Metal-based fine (< 10 μm) and ultrafine (< 0.1 μm) particles might be considered as especially hazardous as they can easily invade the human body via inhalation. Due to the large surface area of nanoparticles and their high reactivity with biomolecules and tissues, they may generate adverse health impacts related to potential oxidative stress, inflammation and generation of reactive oxygen species (e.g., Shuster-Meiseles *et al*. 2016).

Urban airborne particulate matter (PM) is often a complex mixture of phases derived from multiple sources. Many researchers have addressed traffic combustion-derived emissions and the automotive industry has made a considerable effort to limit tail-pipe emissions. However, investigation of the pollution originating from non-exhaust sources has received relatively little attention. Studies by Querol *et al*. (2004) showed that the non-exhaust particles constitute a similar proportion of the airborne PM as exhaust emissions. Perricone *et al*. (2016) quantified brake wear emissions and reported that 'low-metallic' brake pads (commonly used in Europe) generate 8 – 91 × 10^{10} particles/stop/brake. Moreover, a great majority of the emitted particles are smaller than 100 nm. Magnetite nanoparticles found in the human brain (Maher *et al*. 2016) are comparable in size, shape and composition to those originating from brake wear (Kukutschová *et al*. 2011), see Fig. 1. The major exposure to airborne PM for many people is from vehicles. Investigation of the sources, contributions, composition and properties of traffic-derived PM is therefore timely and important.

Here, we show the magnetic properties of three types of commercially available brake pads ('high metallic', 'low metallic' and 'non-asbestos organic'). The analysis reveals considerable differences in magnetic properties between the different pads, especially in the contribution of ultra-fine, superparamagnetic grains. The results are also compared with magnetic properties of roadside dust, from our earlier studies.

Keywords: environmental magnetism, traffic-derived pollution, non-exhaust emissions.

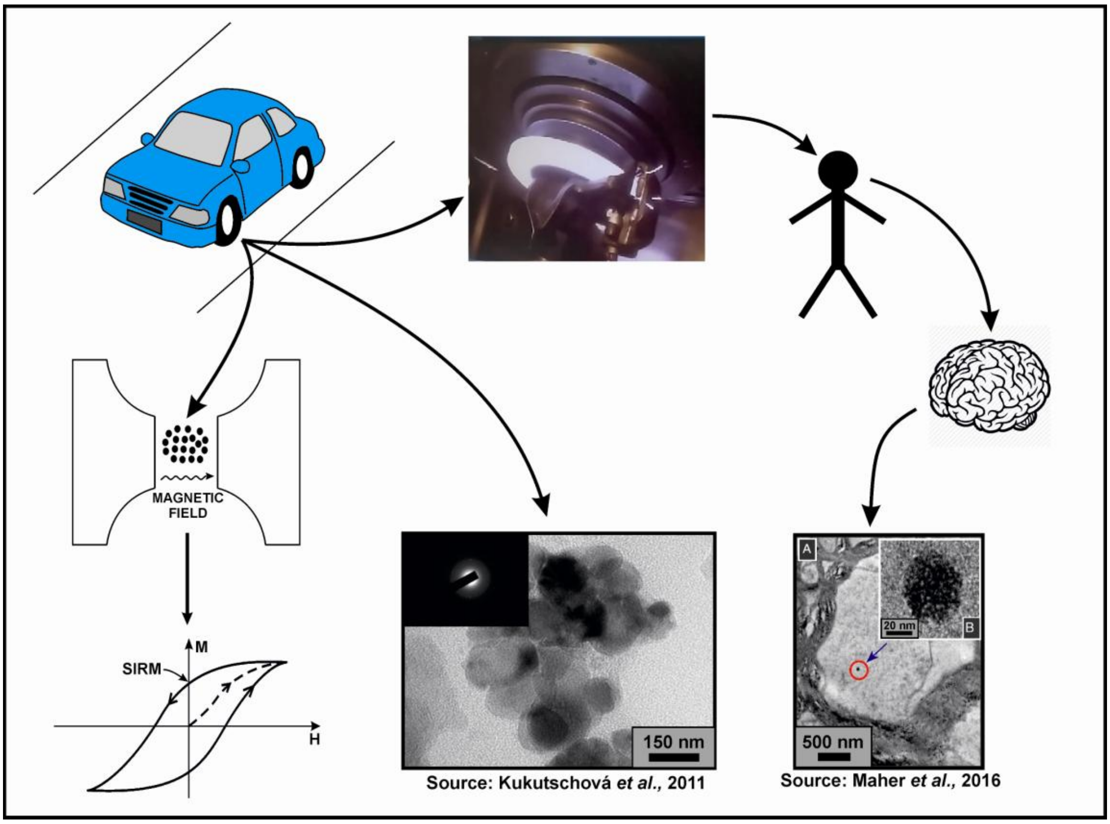

Fig. 1. Rationale behind the studies of brake wear emissions (Kukutschová *et al*. 2011, Maher *et al*. 2016).

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