NOTICE ON A METHODOLOGY FOR MONITORING ULTRAFINE PARTICLES/NANOPARTICLES IN MICROENVIRONMENTS

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Abstract

The influence of very ultrafine particulate, lying in the nano range, on human health has already been reported to be of much concern as airborne nanoparticles can result both from nanotechnologies processes as well as from macroscopic common industrial processes such as granulated materials handling and metals processing.

Bearing in mind the potential adverse health effects of ultrafine particles it is of paramount importance to perform effective monitoring of nano sized particles in several microenvironments, which may include ambient air, indoor air and also occupational environments. In fact, effective and accurate monitoring is the first step to obtain a set of data that could be used further on to perform subsequent evaluations such as risk assessment and epidemiologic studies, thus proposing good working practices such as containment measures in order to reduce occupational exposure.

At this time, occupational health risks associated with manufacturing and use of nanoparticles are not yet clearly and fully understood. However, workers may be exposed to nanoparticles through inhalation at levels that can greatly exceed ambient concentrations.

Current workplace exposure limits, that have been established long ago, are based on particle mass criteria. However, this criteria does not seem adequate in what concerns nanoparticles as these materials are, in fact, characterized by very large surface areas, which are, in fact, the distinctive characteristic that could even turn out an inert substance into another substance, having the same chemical composition, but exhibiting very different interactions with biological fluids and cells, which may become beneficial or not. Therefore, it seems that assessing human exposure based only on the mass concentration of particles, which is widely adopted for particles over 1 µm, could not be adequate for this particular case. As a matter of fact, nanoparticles have far more surface area for its equivalent mass of larger particles, which increases the chance they may react with body tissues. Thus, a growing number of experts have been claiming that surface area should be used instead for nanoparticle exposure and dosing. As a result, assessing workplace conditions and personal exposure based on the measurement of particle surface area is becoming of increasing interest. It is well known that lung deposition is the most efficient way that airborne particles can enter the body and potentially cause adverse health effects. Properties that contribute to the toxic effects of nanoparticles include: solubility, particle morphology, particle size, composition, surface chemistry, surface coatings and surface area. If nanoparticles can deposit in the lung and remain there, have an active surface chemistry and interact with the body, then, there is some potential for exposure and dosing. Oberdörster showed that surface area plays an important role in the toxicity of nanoparticles and this is the measurement metric that best correlates with particle-induced adverse health effects. The potential for adverse health effects seems to be directly proportional to particle surface area.

This paper presents an useful methodology for monitoring ultrafine particles/nanoparticles in several microenvironments, using on-line analyzers and also sampling systems that allow further characterization on collected nanoparticles. This methodology was validated in some case studies that are presented in the paper which are the monitoring of nano sized particles in outdoor atmosphere and in a welding workshop, and seems to be effective for monitoring ultrafine particles in the above mentioned environments (being indoor or even outdoor) as well in other similar situations. The use of these equipment and experimental procedure provides very useful information for assessment of exposure as well as for risk assessment also. The obtained information can be easily related with specific process conditions and physical constraints and, therefore, helps in the determination of the

real origin of the airborne ultrafine particles, and also to the definition of appropriate containment measures for emitted nanoparticles and good operational practices in order to reduce occupational exposure.

Figure 1 shows obtained TEM images of collected ultrafine particulate during MAG welding using gas mixture Ar+18% CO_2 (top) and Ar+8% CO_2 (bottom).

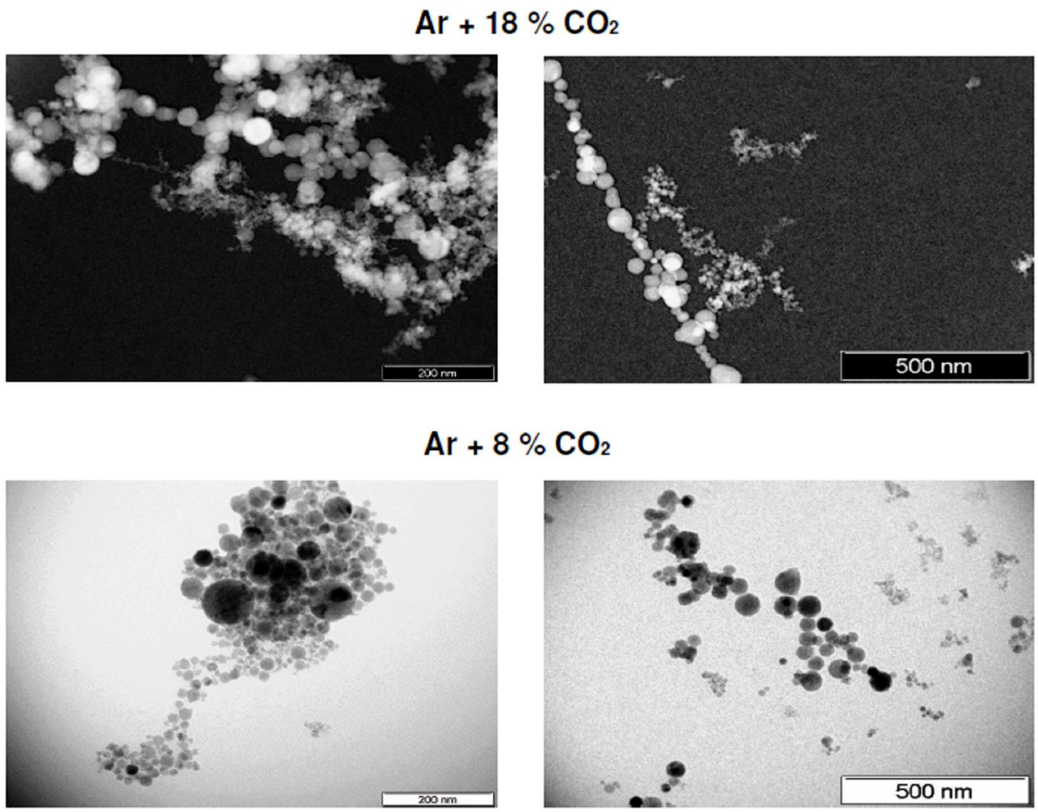

Figure 1. TEM images of collected ultrafine particulate during MAG welding using gas mixture Ar+18% CO_2 (top) and Ar+8% CO_2 (bottom).