Introduction

• engineered nanoparticles and unintentional production of nanoparticles
• forming nanoparticles by dissipation or by thermal processes
• important source of contamination of working environment

The need to characterize the potential adverse impact of nanomaterials represents the first step in monitoring and control of air quality with respect to nanoparticles. Nanoparticles released to workplace atmosphere (from engineered NP and/or unintentional production of nanoparticles following various metal manufacturing processes) pose relatively new very well understood phenomena. The study of various nanoparticles has shown that they can pass biological barriers including cell membranes, many of them exhibit high mobility in environment and living organisms and some have negative health effects. Consequently, the investigation of possible health effects of nanoparticles started and nowadays it is a concern of several research projects including international ones. Nevertheless, the study of health effects is complicated and still in early stages and is why the precautionary principle should apply in occupational and safety issues and environmental health considerations related to nanoparticles. The behaviour of engineered nanoparticles has attracted attention also to other type of nanoparticles in working and living environment. In particular, the non-intentionally produced nanoparticles (engineered nanoparticles and unintentional production of nanoparticles, etc.) have a concentration of engineered nanoparticles and unintentional production of nanoparticles, i.e., non-intentionally produced nanoparticles. Among various types of engineered nanoparticles, it is possible that the most useful for understanding the nanoparticles released to environment is the study of various engineered nanoparticles following various metal manufacturing processes (engineered nanoparticles and unintentional production of nanoparticles).

Experimental method

• industrially used metals – Al, Pb, Sn, Zn, alloy Pb50-Sn50
• temperatures above melting point of metal
• particular nanoparticles aerosol fractions concentration measured by FMPS 3091 spectrometer

To examine the possibility of nanoparticles creation from molten metals in contact with gaseous phase, following pilot tests were realized. In the air-tight closed ceramic cup, industrially used metals with low melting points (Al, Pb, Sn, Zn and alloy Pb50-Sn50) were melted and purged with nitrogen. The controlled flow of inert gas (nitrogen and volume of nitrogen bubbled throw molten metal was investigated. Temperature, 700 and 900 deg C was examined. To compute the amount of distributed NPs was measured by optical particle counter and diluted into range 5
to 100 nm measured by FMPS 3091 spectrometer. Samples of all tested metals and alloy aerosols were collected during the last test phase at the highest testing temperature by Nano ID WRAS sampler (Fig. 3) for subsequent SEM and ICP-MS analyses.

Results

• high temperature leads to production of fine nanoparticles
• difficult finding of common trend in behaviour of nanoparticles
• changes in fractioning

The experiments show that high temperature (gas phase) leads to significant increase of fine NPs (5 – 12 nm) of all tested metals (Fig. 3 and Fig. 4). The relationship between metal vapour partial pressure and the quantity of distributed NPs cannot be clearly identified. Further, the relationship between purged nitrogen amount and quantity of distributed NPs is rather ambiguous. The experimental results suggest that there is changing of fractioning. Changing the dynamics of purged nitrogen changed distribution of NPs, what is can be caused by different mechanisms of particles generation. The series of concurrent processes (evaporation followed by condensation, oxidation, splashing) are proceeding during the metal melting and differently sized particles are generated.

Discussion and conclusion

Understanding physical and chemical properties of engineered nanoparticles or unintentionally generated nanoparticles in industry is an essential task of health and safety supervisors. Particularly, the management of the risk of uncontrolled and unintentional generation of nanoparticles and estimation of worker’s personal exposure for further risk assessment. The results of this pilot test shall be exploited in immediate future in workplace exposure assessment methodology, as primary information about potential health risk for further risk assessment and management.