Nanoparticles Personal Exposure Measurement Using a Novel Active Personal Nanoparticle Sampler During Machining and Weldind of Nanomaterials.

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NANOPARTICLES PERSONAL EXPOSURE MEASUREMENT USING A NOVEL ACTIVE PERSONAL NANOPARTICLE SAMPLER DURING MACHINING AND WELDING OF NANOMATERIALS

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INTRODUCTION

Development of nanotechnology has grown very rapidly in past decades. Therefore, it has become increasingly important to monitor the exposure of workers in nanoparticle-based manufacturing operations. In order to determine real personal exposure, it is advisable to take a sample within the worker's breathing zone. To perform this task, there is not much of a choice yet, since experimental methods are still under development. Recently, a novel active personal nanoparticle sampler (PENS) has been developed, collecting both respirable mass fraction (RPM) and nanoparticles (NPs) simultaneously (Tsai *et al.*, 2012).

EXPERIMENTAL SETUP

Measurements of personal exposure to nanoparticles took place at the Technical University of Liberec, where researchers attempt to develop a new thermoplastic or reactoplastic (thermoset) composite material exhibiting comparable performance characteristics with steel, with regard to its low thermal expansion, hardness, and resistance to surface scratching. The researchers were divided into four groups that worked in two different workshops. Two groups were exposed to particles from machining (milling and grinding), the other two groups to welding particles, each group for approximately 180 minutes. In the "machining" group there was always one miller and one grinder, in the "welding" group there was always one welder, and the rest of workers was 2-10 meters from the particle source. Each worker was equipped with a personal sampling system consisting of one PENS, a battery and a personal pump. The measurement of exposure was carried out using the PENS, which consists of three main parts (Figure 1). The first part is a respirable cyclone, cutting off particles larger than 4 μm in aerodynamic diameter. The second part is a microorifice uniform deposit area impactor (MOUDI) with the cut-point of 100 nm. Particles ranging from 100 nm to 4 μm in diameter are collected on the impaction plate covered with a 13 mm Teflon filter (PTU021350, Sterlitech Corp., USA) coated with Apiezon L to avoid particle bounce and supported by 25 mm aluminium foil. NPs are collected in a filter cassette containing a 37 mm PTFE filter with PMP support ring (225-1709, SKC Inc., USA). To achieve uniform particle deposition and suppress particle bounce, a stepper motor was used to rotate the impaction plate at 1rpm. Sampling flow rate was 2 l/min. Both RPM and NPs filters were analyzed gravimetrically on a M5P balance (Sartorius, Germany, 1 µg resolution).

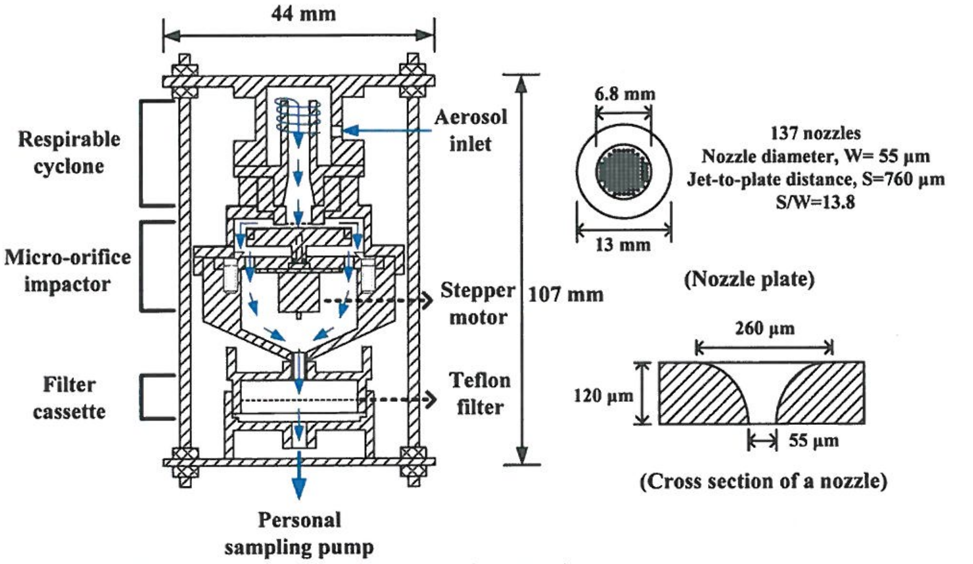

Fig. 1: Schematic diagram of PENS (Tsai *et al.*, 2012).

RESULTS AND CONCLUSIONS

The results (Table 1) showed that workers operating the machines emitting particles (operators) were exposed to substantially higher personal doses of both RPM and NPs in comparison to their peers present in the same workspace but being farther from the emission source. The differences between exposures of operators and other workers in the case of milling and grinding were rather moderate (2x-3x) both to RPM and NPs. On the other hand, in both shifts with welding the operators were exposed to 4x – 10x higher doses of RPM, while in the case of NPs the doses were only 2x-4x higher.

Tab. 1: Mass concentration of RPM and NPs during machining and welding (µg/m³).

	Machinist/welder		Others (average)	
	RPM	**NPs**	**RPM**	**NPs**
Grinding	31	114	22	37
Milling	38	58		
Welding I	895	144	232	98
Welding II	2671	267	272	66

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