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Characteristics of the Particle Size Distribution and Exposure Concentrations of Nanoparticles Generated from the Laser Metal Deposition Process

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Abstract : The objectives of the present study are to characterize nanoparticles generated from the laser metal deposition (LMD) process and to estimate particle concentrations deposited in the head (H), that the tracheobronchial (TB) and alveolar (A) regions, respectively. The studied LMD chamber (3.6m × 3.8m × 2.9m) is installed with a robot laser metal deposition machine. Direct-reading instrument of a scanning mobility particle sizer (SMPS, Model 3082, TSI Inc., St. Paul, MN, USA) was used to conduct static sampling inside the chamber for nanoparticle number concentration and particle size distribution measurements. The SMPS obtained particle number concentration at every 3 minutes, the diameter of the SMPS ranged from 11~372 nm when the aerosol and sheath flow rates were set at 0.6 and 6 L / min, respectively. The resultant size distributions were used to predict depositions of nanoparticles at the H, TB, and A regions of the respiratory tract using the UK National Radiological Protection Board's (NRPB's) LUDEP Software. Result that the number concentrations of nanoparticles in indoor background and LMD chamber were 4.8×10^3 and 4.3×10^5 # / cm^3, respectively. However, the nanoparticles emitted from the LMD process was in the form of the uni-modal with number median diameter (NMD) and geometric standard deviation (GSD) as 142nm and 1.86, respectively. The fractions of the nanoparticles deposited on the alveolar region (A: 69.8%) were higher than the other two regions of the head region (H: 10.9%), tracheobronchial region (TB: 19.3%). This study conducted static sampling to measure the nanoparticles in the LMD process, and the results show that the fraction of particles deposited on the A region was higher than the other two regions. Therefore, applying the characteristics of nanoparticles emitted from LMD process could be provided valuable scientific-based evidence for exposure assessments in the future.

Keywords : exposure assessment, laser metal deposition process, nanoparticle, respiratory region
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