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ID-5-P-1505 Inhalation tests of carbon nanotubes using rats

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Industrial applications of nanomaterials are reported in many fields recently. However, the toxicity of these nano-materials for the human is not clear, so the toxicity and risk assessment of nanomaterials are important. Regulation of nanomaterials is also discussed in Organization for Economic Co-operation and Development (OECD). Authors have reported the toxicity of fullerene, multi-wall carbon nanotube (MWCNT), and single-wall carbon nanotube (SWCNT) using the intratracheal instillation in rat lung. On the other hands, an inhalation test using animal is the gold standard ones to estimate the harmful effects of inhaled chemicals. In this study, the inhalation tests using rat of MWCNT, and SWCNT were performed, and the morphology of alveolar macrophage in rat lung was examined by using transmission electron microscope (TEM).

The aerosols of MWCNT or SWCNT were generated from their liquid dispersions. The average diameter of MWCNT was 48nm. The average diameter of SWCNT was 1.8 nm, and SWCNTs were bundled. Rats were exposed to the aerosol for 6 hours a day, 5 days a week, for 4 weeks in a whole-body exposure chamber. The average mass concentrations of aerosol were 0.038 mg/m3 for MWCNT, and 0.03 or 0.13 mg/m3 for SWCNT. The lung tissues after three days, one month after the inhalation test were observed by TEM. The lung tissue was fixed using glutaraldehyde and osmium tetroxide solution, and then dehydrated in ethanol, and embedded in epoxy resin. Ultrathin sections were cut on a diamond knife with microtomy. The stained specimens were also examined using conventional biological TEM (Hitachi, H-7600). The zero loss imaging of the non-stained tissue was performed by an energy-filtering TEM with the high-resolution objective lens (Carl Zeiss, EM922HR).

TEM image of lung tissue at 3 days after inhalation of MWCNT was shown in Figure 1 (a), and the magnified image of boxed area in Figure 1(a) was shown in Figure 1(b). Fibrous objects are observed at the cytoplasm of macrophage. According to high- resolution analysis, these fibers are MWCNT, and MWCNT keeps the tube and the graphitic structures. This is because that graphite is chemically stable. In the tissue at 1 month inhalation of MWCNT, MWCNT is still remaining in alveolar macrophage. TEM image of the alveolar macrophage at 3 days after inhalation of SWCNT was shown in Figure 2(a). Black particles are observed in phagosome of macrophage. Magnified image of these black particles was shown in Figure 2(b). Fibrous structures with nanometer size are observed and it is clarified that SWCNT is taken up by macrophage. In summary, the MWCNT and SWCNT, which were inhaled in lung, were taken up in the alveolar macrophage.

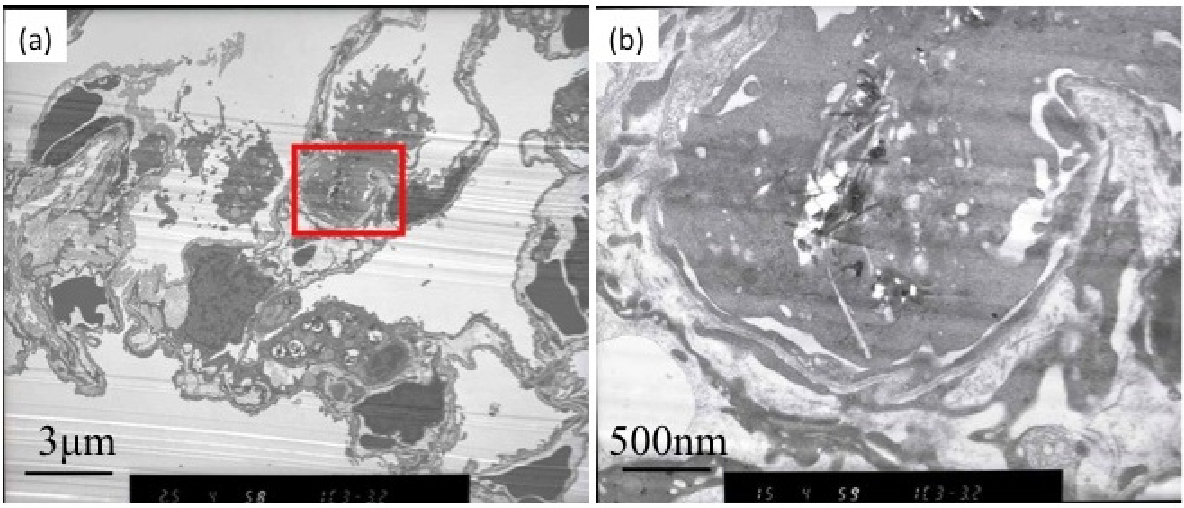

Fig. 1: (a) Alveolar macrophage in the rat lung at 3 days after inhalation of MWCNT, and (b) magnified images of boxed area in (a)

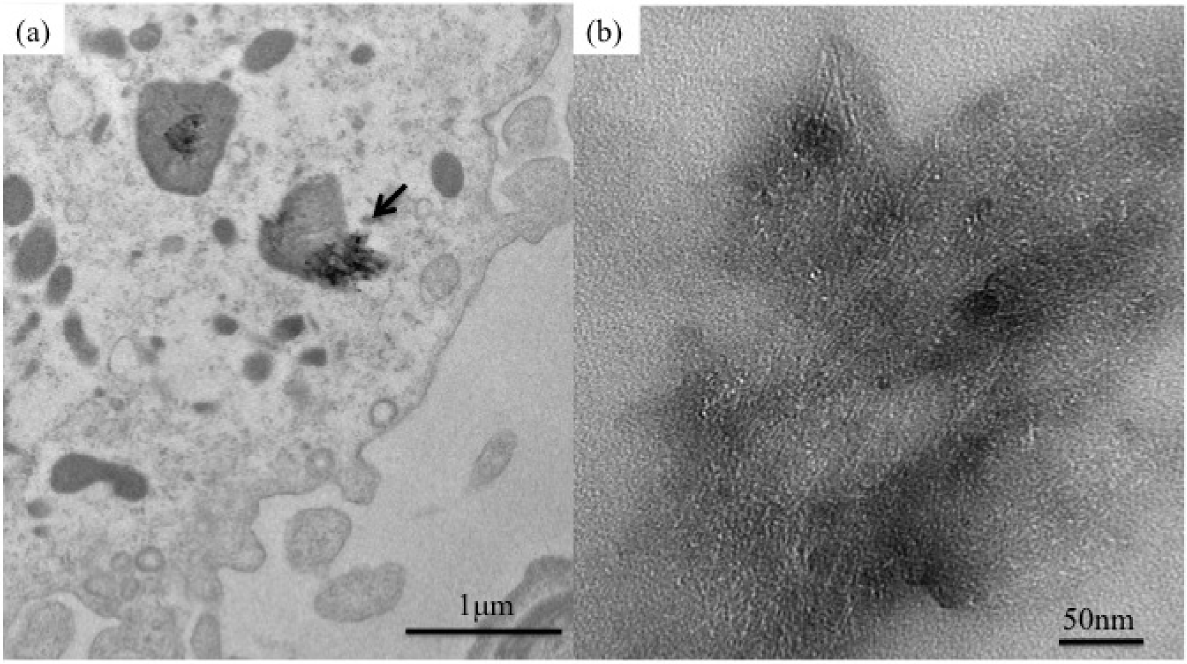

Fig. 2: (a) Alveolar macrophage in the rat lung at 3 days after inhalation of SWCNT, and (b) magnified images of phagosome in (a)