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Formation of Fine Particles of Tungsten by Electron Beam

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Recently fine particles of various materials are required for their particular properties compared with bulk materials. However, the formation of fine particles of high melting temperature materials is still very difficult for conventional heat sources such as arc or plasma jet. In this report, electron beam with high power density is applied to fine particle formation of tungsten with a particle size of around 100nm in vacuum condition. Particle sizes and yields of fine particles are measured at various electron beam currents and irradiation times.

Figure 1 shows the experimental setup. An electron beam with an acceleration voltage of 70kV, beam currents of 10-40mA and a_b value of 1.0 was impinged onto a tungsten powder specimen of 20 μm in diameter inside an alumina crucible of 26mm in diameter and 30mm in height under a vacuum condition of 1P. From the observation by a high speed video camera of 200fps, it was found that the beam scanning speed and scanning pattern affected the melting condition of specimen. In order to melt the surface uniformly and to form a large amount of fine particles, the electron beam was scanned by a function generator and a beam deflector with a scanning pattern shown in **Fig.2**. Beam was

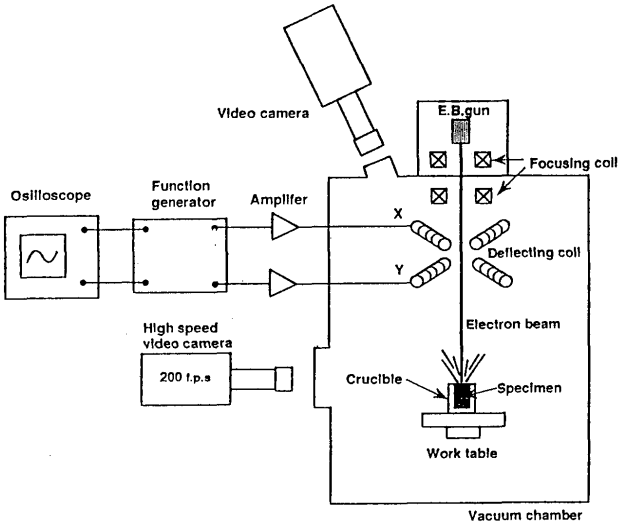

Fig.1 Experimental apparatus.

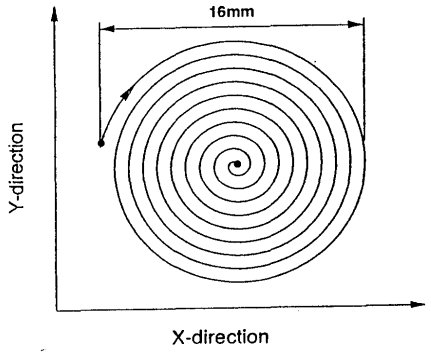

Fig.2 Beam scanning pattern.

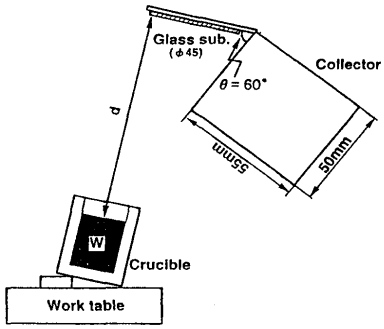

Fig.3 Collection system of fine particles.

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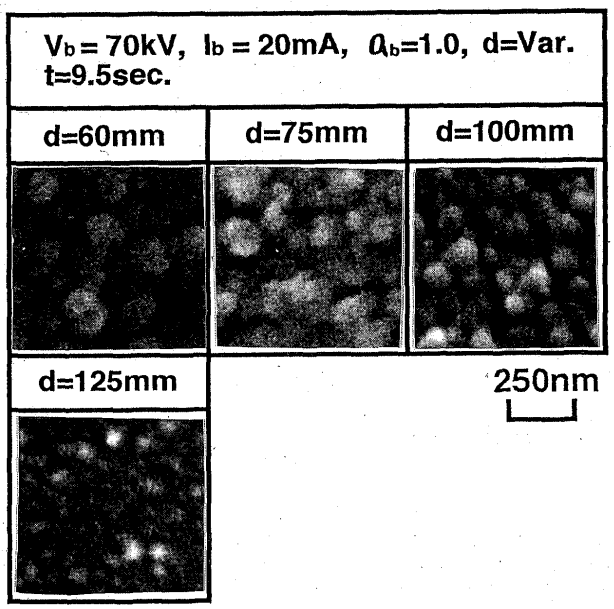

Fig.4 SEM photographs of fine particles at various collection distances.

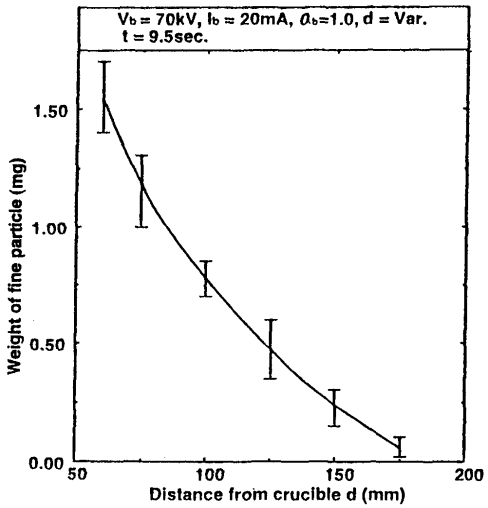

Fig.5 Weight of fine particles at various collection distances.

scanned in a spiral pattern with a constant speed of 50mm/sec in order to irradiate a new surface of the specimen only once in one scanning time. Fine particles formed by electron beam irradiation were collected on a glass substrate as shown in **Fig.3** and measured by a scanning electron microscope and an analytical balance.

Figure 4 shows SEM photographs of fine particles obtained on a glass substrate located at various distances from the crucible. Particle size is decreased with increasing distance and fine particles of around 100nm were obtained at a distance of 125mm to the crucible. Average particle diameters and yields of fine

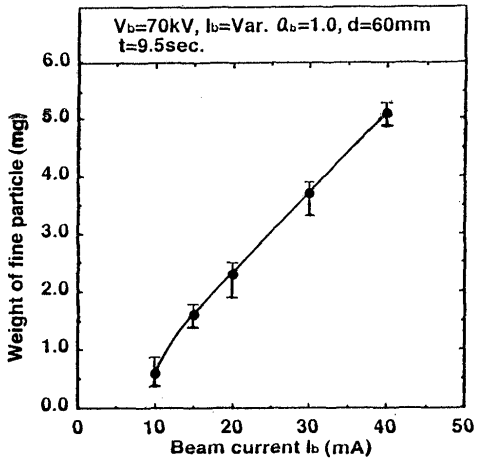

Fig.6 Weight of fine particles obtained at various beam currents.

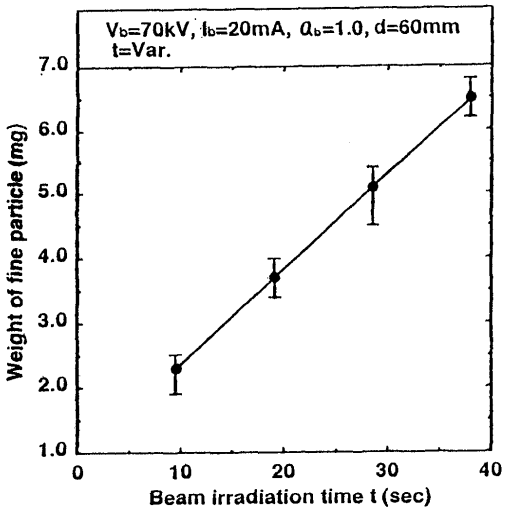

Fig.7 Weight of fine particles at various irradiation time.

particles on glass substrate are shown in **Fig.5** at various distances from the crucible. Both average particle diameters and yields of fine particles are decreased with a collection distance. The yields of fine particles were increased with beam current and irradiation time as shown in **Fig.6** and **Fig.7**. This shows the importance of irradiation conditions for fine paticle formation.

Conclusively, an electron beam having high energy density can applied to fine particle formation of tungsten in vacuum condition. Tungsten powder of 20 μm was irradiated by an electron beam of 40kV and 20mA at a_b value of 1.0 in vacuum condition of 1P and fine particles of around 100nm were formed on glass substrate at a distance of 125mm from the crucible.