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タングステン材料の強度に及ぼす組織異方性の影響
Effect of Material Anisotropy on Strength of Tungsten Materials

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Introduction： Tungsten (W) is a promising candidate for plasma-facing materials in fusion reactors because of its high melting point, thermal conductivity and sputtering resistance. Tungsten shows brittleness in the temperature range lower than Ductile-Brittle-Transition-Temperature (300-600°C) where initiated crack can propagate through the whole material immediately and then the material fails, structure control (i.e., hot rolling or wire drawing) has taken so that increasing crack propagation resistance. The rolled tungsten which is expected to use in diverter is considered to place as rolling direction is parallel to heat input direction in order to prevent decreasing thermal conductivity by crack initiation and propagation. It is important to investigate the mechanical properties of through-thickness direction of rolled W because the stress due to thermal expansion or thermal shock may be introduced along through-thickness direction. Bending properties of tungsten and its alloys were investigated in our previous work, and the fracture stress along through-thickness direction was smaller than other directions. We investigate the effect of anisotropy on strength of tungsten materials by Electric Back Scattering Diffraction (EBSD), Scanning Electron Microscopy (SEM) observation and tensile test using new designed 7 mm length tensile test specimen, which is cut along through-thickness direction.

Experimental： We used a pure W material fabricated by rolling after powder sintering by. A.L.M.T corp., Japan. It has 7mm thickness and was stress relieved by heat treatment at 900°C for 20 min, specimens were cut along through-thickness direction (see Fig.1). Some of specimens were heat treated for recrystallization at 1500°C for 1 hour. The dimension of specimen was 7 x 1.2 x 3.4 mm and cross section of gauge section was 0.5 x 1.2 x 1.2 mm. The shape of this specimen was optimized based on calculations of stress on shoulder of the specimen. Tensile test was performed to 900°C and 1500°C heat-treated specimens at room temperature (in air) and 700°C (in vacuum), at a strain rate of 0.001 sec^{-1}. EBSD and SEM observation was conducted in order to investigate the relationship between structure and fracture mode of specimen.

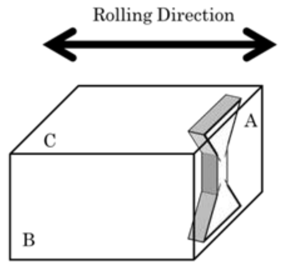

Fig.1 Cutting direction of specimens

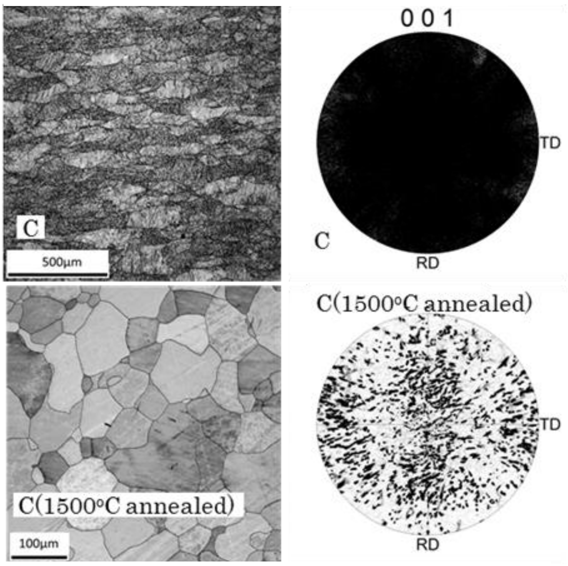

Fig.2 Boundary map and pole figure of C surface

Results & Discussions： The result of EBSD observation to C surface (see Fig.1) is shown in Fig.2. Many low-angle grain boundaries were observed in 900°C heat-treated W and the pole figure showed scattered spots. Elongated grains of 900°C heat-treated specimen had changed to equiaxed grains after 1500°C recrystallization annealing and spots were not recognized in the pole figure.

In our presentation, we will report effect of anisotropy on mechanical property and fracture mechanism on W materials by tensile test and SEM observation.