Thermal stability of a highly-deformed warm-rolled tungsten plate in the temperature range 1100 °C to 1250 °C

Pure tungsten is considered as armor material for the most critical parts of fusion reactors (i.e. the divertor and the first wall), among other reasons due to its high melting point (3422 °C) and recrystallization temperature. The thermal stability of a pure tungsten plate warm-rolled to a high plastic strain by 90% thickness reduction was investigated by isothermal annealing for up to 190 h in the temperature range between 1100 °C and 1250 °C. Vickers hardness testing allowed tracking the changes in mechanical properties caused by recovery and recrystallization. The hardness evolution could be rationalized in terms of a logarithmic recovery kinetics and a Johnson-Mehl-Avrami-Kolmogorov recrystallization kinetics accounting for an incubation time of recrystallization. The observed time spans for recrystallization and the corresponding recrystallization activation energy for this highly deformed plate suggest that large plastic deformations (e.g. applied during shaping) are only suitable to produce tungsten components to be used at relatively low temperatures (up to 900 °C for a 2 years lifespan). Higher operation temperatures will lead to fast degradation of the microstructure during operation.