On the Origin of the α-Peak in Vanadium

A low temperature relaxation peak termed the α-peak has been reported by many investigators in *bcc* refractory metals after plastic deformation. The peak has been suggested to be an "intrinsic" dislocation relaxation effect[1], while some investigators have found that hydrogen plays an important role in the appearance of the α-peak in tantalum[2] and niobium[3].

The aim of the present note is to report a similar observation on vanadium. Since oxygen is known to suppress the α-peak[4], we prepared specimens of low oxygen contents by annealing specimen wires with zirconium foils[5]. By virtue of the higher affinity of zirconium than vanadium to oxygen, a large fraction of oxygen in vanadium is removed by the annealing[6] and the treatment is referred to as the zirconium treatment.

Figure 1 shows the internal friction vs temperature curves measured by an inverted torsion pendulum[5], at a heating rate of 1.25°C/min. The oxygen content is estimated to be about 70 at.ppm from the height of the Snoek peak (curve *a′* in Fig. 1); this value should be compared with the value of about 4000 at.ppm before the zirconium treatment. After the deformation of 19% (surface shear strain) in torsion, a large α-peak appears at about −120°C. Incidentally, a small peak observed in the undeformed state is believed to be due to the handling effect.

In the course of the internal friction measurement, the zero point drift of the pendulum was simultaneously recorded as shown in the lower part of Fig. 1; the angle of the rotation is converted to the surface shear strain of the specimen wire. Owen and Scott[7] referred to the effect as the Poynting effect, which is associated with the precipitation or dissolution of hydrides. From the onset temperature of self twisting (∼ −100°C), the hydrogen content in the specimen is estimated at about 500 at. ppm in reference to the solubility data[7].

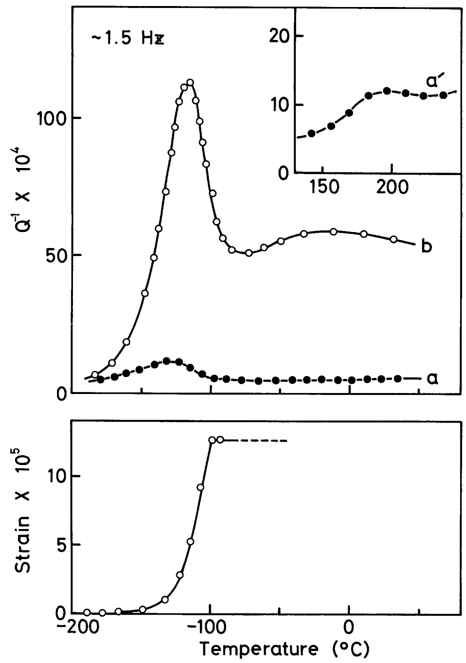

Fig. 1 The internal friction vs temperature curves for a vanadium specimen prepared by a "single zirconium treatment" (see text). Measurements were made at a heating rate of 1.25°C/min.
a: before deformation (the first run)
a′: oxygen Snoek peak
b: after 19% deformation in torsion (the second run)
The lower figure shows the self twisting of the specimen, measured after the second run.

It has been found that the second zirconium treatment with new zirconium foils is effective in reducing the hydrogen content in vanadium. Figure 2 shows the internal friction vs temperature curves for the specimen prepared by the double zirconium treatment. In both the undeformed (*a*) and the deformed (*b*) state, neither the α-peak nor the self twisting of the

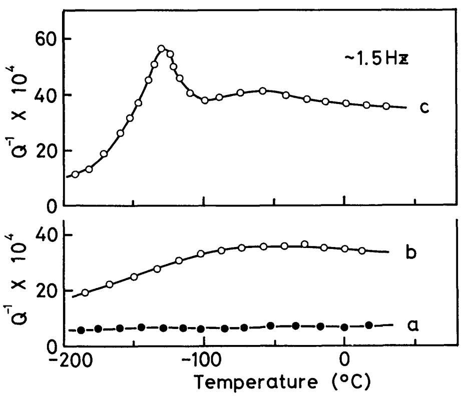

Fig. 2 The internal friction vs temperature curves for a vanadium specimen prepared by a "double zirconium treatment" (see text). Measurements were made at a heating rate of 1.25°C/min.
a: before deformation
b: after 19% deformation in torsion
c: after hydrogen charging ($\simeq$ 50 at.ppm)

specimen was observed. Hydrogen was then added to the deformed specimen by a cathodic charging technique at 0°C. The electrolyte was a 0.1N H_2SO_4 solution and the applied current density was 1 mA/cm^2. After the hydrogen charging, the α-peak was clearly observed (*c*). Thus, it is concluded that the presence of hydrogen is essential for the appearance of the α-peak in vanadium. Detailed description of this work will be published soon.

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