The Portevin-Le Chatelier Effect in Vanadium

The Portevin–Le Chatelier Effect in Vanadium*

H. YOSHINAGA, K. TOMA, K. ABE and S. MOROZUMI

The Research Institute for Iron, Steel and Other Metals

Abstract

In order to examine the temperature and strain-rate dependences of the Portevin-Le Chatelier (P-L) effect, tensile tests were carried out, using vanadium containing 170 p.p.m. of carbon and 42 p.p.m. of oxygen. The results obtained were as follows.

1. The P-L effect is observed in the temperature range from about 200°C to 500°C for a strain rate of 3.3×10^{-5}/sec.

2. The serrations observed after the initial Lüders strain are classified into two types, relatively fine serrations (Type A) and coarser serrations (Type B) which appear intermittently and are observed clearly in the higher temperature region.

3. Type A serration is associated with a very high work-hardening rate, while the rate is smaller with Type B serration.

4. In the lower temperature region, the P-L effect is observed only when the deformation proceeds beyond some critical strain, and the serration increases in stress amplitude with strain, while, in the higher temperature region, Type A serration disappears abruptly at some critical strain. Type B serration remains for some time after Type A serration has disappeared.

5. The apparent activation energy is determined to be 27.9 kcal/mole from the critical conditions for the initiation of the P-L effect. This value agrees well with the activation energies for diffusion of carbon and oxygen in vanadium. A very large value of the energy, 76.7 kcal/mole, is found from the disappearing conditions of Type A serration.

The results as to Type A serration accord with the mechanism of jerky motion of dislocations dragged by solute atmospheres (Yoshinaga and Morozumi 1971a), while those of Type B serration are understandable with the unlocking mechanism.

* The **1536th** report of the Research Institute for Iron, Steel and Other Metals. Published in the Philosophical Magazine, **23** (1971), 1387.