Jpn. J. Appl. Phys. Vol.35(1996) 738-747
Part 1, No. 2A, 15 February 1996
DOI : 10.1143/JJAP.35.738

Anomalous Heat Evolution of Deuteron-Implanted Al upon Electron Bombardment

Kohji Kamada, Hiroshi Kinoshita[1] and Heishitiro Takahashi[1]

National Institute for Fusion Science, Nagoya 464-01, Japan [1]Center of Advanced Research Energy Technology, Hokkaido University, Sapporo 062, Japan

(Received December 7, 1994; accepted for publication November 6, 1995)

Abstract:

Anomalous heat evolution was observed for the first time in deuteron-implanted Al foils upon 175 keV electron bombardment. Local regions with linear dimension of more than 100 nm showed simultaneous transformation from single-crystalline to polycrystalline structure within roughly one minute during the electron bombardment, indicating a temperature rise to above the melting point of Al from room temperature. The amount of energy evolved was estimated to be typically 160 MeV for each transformed region. The transformation was never observed in proton-implanted Al foils. Microstructures in the subsurface layer of the implanted Al, investigated by elastic recoil detection (ERD) method and transmission electron microscopy (TEM), were presented for numerical discussions of the experimental results. Possible causes of the surface melting, such as the heating effect of the electron beam, size effect of the melting point, difference in the implanted depth profiles between hydrogen and deuterium, and possible chemical reactions due to the electron bombardment in D_2 collections, were investigated. We consider that some kind of nuclear reaction occurring in the D_2 collections is the only explanation for the observed melting. The reaction was estimated to continue only for a short time, presumably less than 10^{-10} s, and the energy gain, which is defined as the ratio between the amount of energy evolved and the energy loss of the impinging electros through the Al specimen, amounts to more than 1×10^5.

Keywords:

deuteron implantation, electron bombardment, melting