

【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Engineering)



Title of Project : Establishment of Scientific Basis of the Strength and Reliability of Materials Based on the Order of Atom Arrangement and Its Application to the Explication of the Degradation Process of Various Materials

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Research Area : Engineering

Keyword : Mechanics of Materials in Nano- and Micro-Scale

【Purpose and Background of the Research】

Initial strengthened micro textures of heat-resistant materials disappear due to the increase of operating temperature and mechanical stress for improving the thermal efficiency of various power and chemical plants. The purpose of this study is to develop the observation method of the change of the micro texture from the viewpoint of the order of atom arrangement. The degradation process of the quality of grains and grain boundaries is measured quantitatively in various materials and the strain-induced anisotropic diffusion of component elements is analyzed by applying molecular dynamics for clarifying the dominant factors of the degradation process at elevated temperatures.

【Research Methods】

The crystallinity of grains and grain boundaries was evaluated in this study by *IQ* (Image Quality) value obtained from EBSD (Electron Back-Scatter Diffraction) analysis. The amplitude of *IQ* value varies due to various damages such as vacancies, dislocations, impurities, local strain, and so on. Thus, this *IQ* value is effective for analyzing the grade of damage of atomic configuration, in other words, the order of atom arrangement. In addition, the strength of a grain and a grain boundary is measured separately by developing a micro test system in an electron microscope.

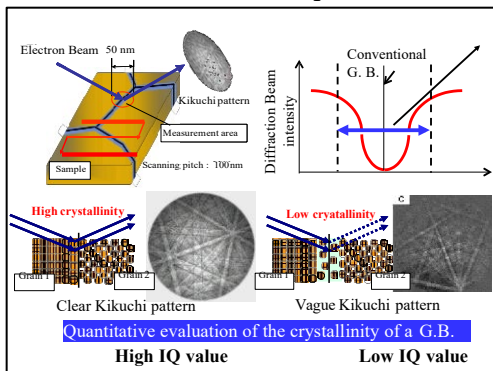


Fig. 1 Quantitative analysis of the crystallinity of a grain boundary

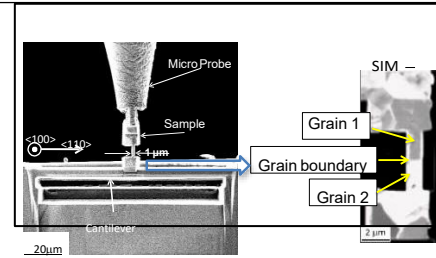


Fig. 2 Micro test system for measuring the strength of a grain and a grain boundary

【Expected Research Achievements and Scientific Significance】

The degree of disorder of atom arrangement caused by various defects such as vacancies, dislocations, the change of local composition, and so on is evaluated quantitatively. In particular, the stress-induced anisotropic diffusion of component element is validated as a dominant factor of the degradation and it is found that there is critical stress at which the accelerated diffusion starts to occur. This *IQ* is effective for evaluating the order of degradation of atom arrangement of various materials at elevated temperatures.

【Publications Relevant to the Project】

- N. Murata, N. Saito, K. Tamakawa, K. Suzuki, and H. Miura, J. of Electronic Packaging, vol. 137 (3), (2015), pp. 031001~031008.
- Suzuki, K., Murata, N., Saito, N., Furuya, R., Asai, O, and Miura H., Jap. J. of Applied Physics, vol. 52, (2013), pp. 04CB01-1~04CB01-8.

【Term of Project】 FY2016-2020

【Budget Allocation】 80,800 Thousand Yen

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