B7

Ni-Co 합금입자가 분산된 알루미나기 나노콤포지트의 기계적 및 자기적 성질
(Mechanical and Magnetic Properties of Ni-Co Alloy Dispersed Al_2O_3-based Nanocomposite)

Synergy Ceramics Lab., FCRA
National Industrial Research Institute of Nagoya
ISIR, Osaka University

오 승 탁 (Sung-Tag Oh)*
M. Awano and M. Sando
K. Niihara

1. Introduction

In purpose of introducing inverse magnetostrictive properties (Villari effect) into structural ceramics, ceramic based nanocomposites dispersed with nano-sized ferromagnets were studied. In this approach, Al_2O_3, which has been well examined as a structural ceramics, and Ni-4.5 wt% Co alloy as a material having high magnetomechanical coupling factor were selected for the ceramic matrix and dispersions, respectively. The relationships between microstructure and properties for the composites were analyzed.

2. Experimental Procedures

Weighed Ni- and Co-nitrate powders, corresponding to Ni-4.5 wt% Co in the final alloy, were initially dissolved in ethanol. Subsequently, α-Al_2O_3 (0.2 μm) was mixed with the solution and milled for 24 h with Al_2O_3 balls. The mixtures would result in 5, 10 and 15% by weight of alloy after sintering. After calcination at 450°C, they were reduced by H_2 and sintered at 1450°C for 1h in Ar under pressure of 30 MPa. For the variation of dispersoid size, the powder mixture with 10 wt% alloy was consolidated by the Pulse Electric Current Sintering (PECS) method at 1350°C for 10 min with heating rate of 100°C/min.

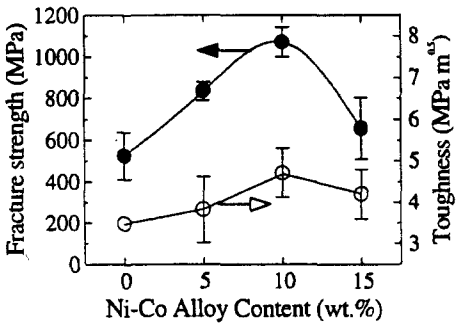

Fig. 1 Variation of fracture strength and toughness for the hot-pressed materials.

3. Results

Relative densities higher than 99% were obtained for the sintered composites. On the basis of X-ray diffraction analysis, these composites were composed of only Al_2O_3 and Ni-Co alloy. The relation between mechanical properties and the alloy content is shown in Fig. 1. By dispersing 10 wt% of alloy, the maximum strengthening of 1070 MPa, which was much higher than that of Al_2O_3, was achieved. Another noteworthy property of this system was the inverse magnetostrictive response involving ferromagnets dispersion. Fig. 2 shows the magnetization change of materials ($\Delta M/M_0$) subjected to applied uniaxial stress. The value increased with increase in applied stress and in alloy content. The composite with 10 wt% alloy sintered by PECS exhibited higher $\Delta M/M_0$ value than that sintered by hot-pressing.

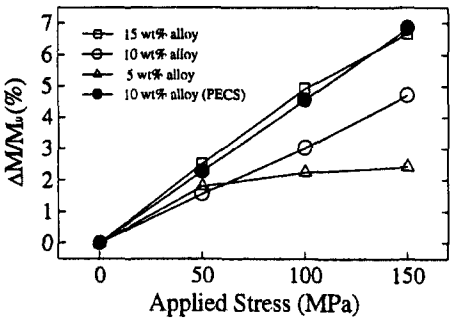

Fig. 2 Magnetization change with applied uniaxial stress for the composites with various alloy content.

Research has been carried out as part of the Synergy Ceramics Project under the Industrial Science and Technology Frontier (ISTF) Program promoted by AIST (Agency of Industrial Science and Technology) of MITI (Ministry of International Trade and Industry), Japan. Under this program, part of the work has been founded through NEDO (New Energy and Industrial Technology Development Organization).