Deformation Processing

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【Staff Members】

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【Research Activities】

Composition dependence of Young's modulus in β Ti-Nb base alloys was investigated in relation to the stability of β phase. A minimum of Young's modulus in the binary alloys appears at such a composition that athermal omega phase transformation is almost completely suppressed. Formation of isothermal omega phase by aging after quenching increases Young's modulus. Optimization of alloy composition in Ti-Nb-Sn alloys leads to low Young's modulus of about 40 GPa. The composition dependence of Young's modulus obtained experimentally in this study can be qualitatively explained by the theoretical discrete-variational Xα cluster method (**Ref.*1***). The composite steel sheet of iron aluminum alloy and steel was produced by clad rolling, in which fabrication condition was determined by deformation resistance between the constituents derived from process simulator. Laminated composite sheet consisting was fabricated using a process condition determined by the flow stress ratio, and exhibits superior deformability. The composite steel could be cold rolled to 120 mm thickness (99.8% reduction), and wound to a coil without damage (**Ref.*2***). The microstructures and high-temperature mechanical properties of an A_2O_3/YAG/ZrO_2 eutectic Melt-Growth-Composite (MGC) solidified unidirectionally were studied. The eutectic MGC has strong preferred growing orientation such that <300> Al2O3 and <100>ZrO2 in the preferred growth orientations. It shows excellent high-temperature strength and can deform plastically above about 1500 K (**Ref.*3***). The hydrogen absorbing properties of binary TiMn2 based alloys were studied. In the annealed alloys, the Mn content of the TiMn2 phase is about 60 at.%; whereas in the alloys beyond 59.4 at.%, it increases with increasing the Mn content of the alloys. Correspondingly, the hydrogen absorbing capacity of the alloys increases with increasing the Mn content up to 59.4 at.%, but rapidly decreases with a further increase of the Mn content. These observations suggest that the alloy composition exhibiting the maximum hydrogen absorbing capacity is determined by a compromise of a high volume fraction and a low Mn content of the $TiMn_2$ phase (**Ref.*4***). The lattice variations and thermal expansion of $Mo(Si_{1-x},Al_x)_2$ with x=0 to 0.6 were investigated. The crystal structure of $Mo(Si,Al)_2$ alters from C11b to C40, and further to orthorhombic C54 and the mean values of the coefficients of thermal expansion (CTE) increases with the increasing Al substitution. In order to reduce the CTE mismatch and to maintain a protective Al_2O_3 formation on $Mo(Si,Al)_2$, it is proposed to incorporate materials with lower CTEs into C40-type $Mo(Si,Al)_2$ with a high Al content (**Ref.*5***).

1. Ozaki T, Matsumoto H, Watanabe S, Hanada S
Beta Ti alloys with low Young's modulus
Mater. Trans. 45 (8): 2776-2779, 2004

2. Masahashi N, Komatsu K, Watanabe S, Hanada S
Microstructure and properties of iron aluminum alloy/CrMo steel composite prepared by clad rolling
J. Alloy.Compd.379 (1-2): 272-279, 2004

3. Murayama Y, Hanada S, Lee JH, Yoshikawa A, Fukuda T
Microstructure and high-temperature strength of directionally solidified Al_2O_3/YAG/ZrO_2 eutectic composite
Mater. Trans. 45 (2): 303-306, 2004

4. Semboshi S, Masahashi N, Hanada S
Composition dependence of hydrogen absorbing properties in melt quenched and annealed TiMn2 based alloys
J. Alloy.Compd. 379 (1-2) : 290-297, 2004

5. Tabaru T, Shobu K, Sakamoto M, Hanada S
Effects of substitution of Al for Si on the lattice variations and thermal expansion of $Mo(Si,Al)_2$
Intermetallics 12 (1): 33-41, 2004

【Plan】

New titanium-based alloys aiming for low Young's modulus and super-elasticity will be studied. Based on the previous result for Ti-Nb-Sn ternary alloy, new designed alloy with Al and V replacing for Sn and Nb, respectively, will be investigated. In addition to alloy composition and microstructure controlling, phase stability controlling by thermo-mechanical treatment is applied in order to improve the properties. Moreover, various materials processing methods will be applied to fabricate the material to the arbitrary shape. In the study of functional laminated composite of Fe-Al alloy and steel, surface coating of Al_2O_3 or TiO_2 will be applied to improve the corrosion resistance in various aqueous solutions. The corrosion mechanism of the coated composite in aqueous solution will be elucidated by both electrochemical experiments and surface analysis using XPS and SIMS. In the study of pulverization by hydrogenation processing, the effect of temperature, pressure, cycle and duration time in hydrogenation on pulverization will be studied. Furthermore, the electrochemical properties for the condenser made of the pulverized powders will be investigated by comparing with that of commercial condenser. In the study of visible-light sensitive TiO_2 photocatalysis, the photocatalysis activity of alloyed TiO_2 will be investigated to improve the property under visible light illumination based on the electron-neutrality concept. A new metallic biomaterial coated with visible-light sensitive TiO_2 photocatalysis such as sterilization of chemical SUBSTANCE and self-cleaning will be fabricated. Furthermore, plasma treatment by plasma reactor and SPS process will be applied to fabricate bulk TiO_2 material with superior photocatalysis properties.