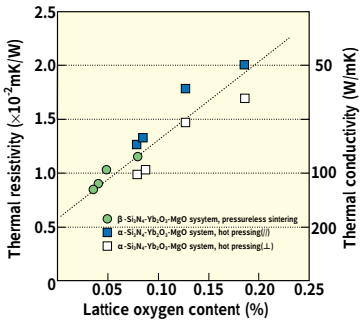
Nanotechnology and Materials Science & Technology

Development of High Thermal Conductivity Silicon Nitride

Silicon nitride (Si_3N_4) is a serious candidate for high performance ceramic substrates because of its excellent mechanical properties and high intrinsic thermal conductivity. Recently it has been revealed that lattice oxygen content in Si_3N_4 crystal is a crucial factor governing the thermal conductivity of silicon nitride ceramic as shown in the figure. Based on this result, silicon nitride with high thermal conductivity of about 150W/(m•K) has been developed at the Synergy Materials Research Center. When used magnesium silicon nitride ($MgSiN_2$) as a part of sintering aids, extremely low level of lattice oxygen content can be achieved, which leads to the high thermal conductivity of 150W/(m•K). The value achieved in Si_3N_4 is equivalent to that of aluminum nitride (AlN) which has being used as heat-sinks for IC packages. Silicon nitride has about two times higher in mechanical strength and toughness than AlN, that might be expected a wide applications as a material having both superior mechanical properties and high-thermal conductivity.



Effect of lattice oxygen content on thermal resistivity and thermal conductivity for silicon nitrides fabricated by various methods.

Kiyoshi HIRAO
Synergy Material Research Center
e-mail:
k-hirao@aist.go.jp
AIST Today;
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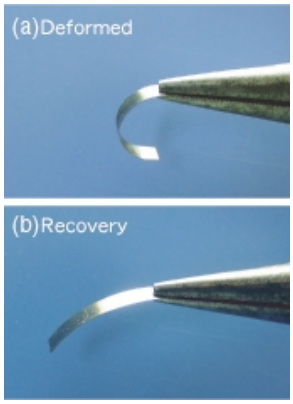
Development of Co-Ni-Al-based Ferromagnetic Shape Memory Alloys

A ferromagnetic shape memory alloys has been developed in Ni-Co-Al system. The alloys exhibit a paramagnetic/ferromagnetic transition besides a thermoelastic martesitic transformation from the B2 to $L1_0$ structure. The Curie and the martensitic start temperatures in the $L1_0$ phase can be individually controlled in a range from -150 to 150°C. Some of the specimens were found to undergo the martensitic transformation from the ferromagnetic B2 to the ferromagnetic $L1_0$, accompanied by a shape memory effect. The workability of the new alloys is quite better than other ferromagnetic shape memory alloys.



Demonstration of shape memory effect of Co-Ni-Al-based ferromagnetic shape memory alloy. (a) Alloy was deformed at 10°C and (b) heated over A_f temperature

Katsunari OIKAWA
Institute for Structural and Engineering Materials
k-oikawa@aist.go.jp
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