FUNDING PROGRAM FOR NEXT GENERATION WORLD-LEADING RESEARCHERS

Project Title: Design of high temperature shape memory alloys to improve combustion efficiency of Turbine	
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1. Background of research

The energy and transport sectors occupies 34% and 20% in domestic emission of CO_2. Up to now, temperature capability of high-temperature materials have been raised in order to improve the combustion efficiency of steam-power generation and aero engine resulting suppression of consumption of fossil fuel and reduction of emission of CO_2. However, improvement of temperature capability has limitation and new trials are necessary to improve combustion efficiency.

2. Research objectives

Controlling of gas flow rate and gas leakage in combustion system is one of new trials to improve combustion efficiency. It is necessary to control clearance corresponding with work temperature. Shape memory alloys which change their shape depending temperature are one candidate to control clearance. However, there is no predominant shape memory alloys which can work at high temperature in gas turbine. In this research, high-temperature shape memory alloys will be developed to improve combustion efficiency.

3. Research characteristics (incl. originality and creativity)

The original and new points of this study are development of high-temperature shape memory alloys for clearance controlling as new technology to improve combustion efficiency. The temperature limitation of commercial shape memory alloys is up to 100 degree C. We focus on new compounds as high-temperature shape memory alloys and develop alloys which can be used at temperatures between 400 and 600 degree C.

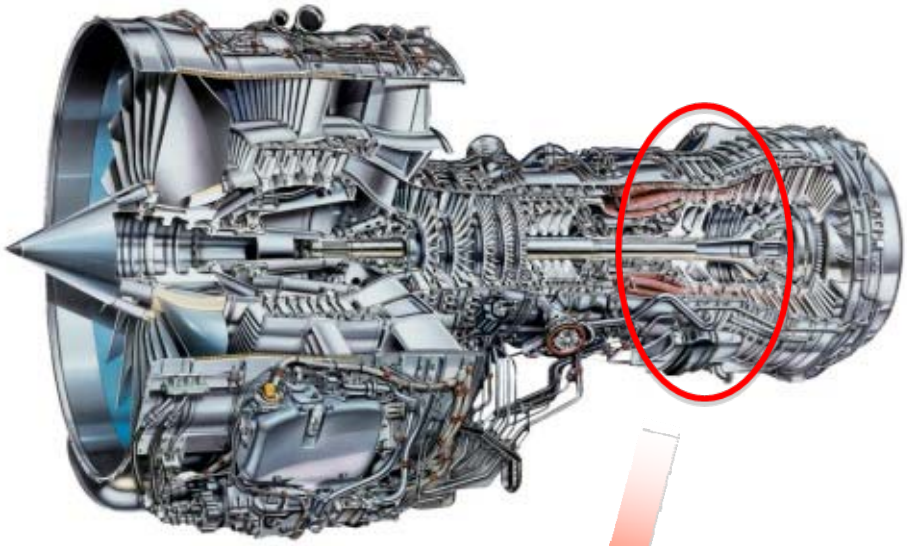
4. Anticipated effects and future applications of research

High temperature shape memory alloys can control clearance. The clearance control in addition of the convention way such as improving of temperature capability enables improvement of combustion efficiency. This also causes reduction of emission of CO_2. Furthermore, high-temperature shape memory alloys can be used in high-temperature equipment because they change their shapes depending on temperature without any engine such as motor.

Background

Reduction of CO_2 emission, Suppression of fossil fuel

→High efficiency of combustion system



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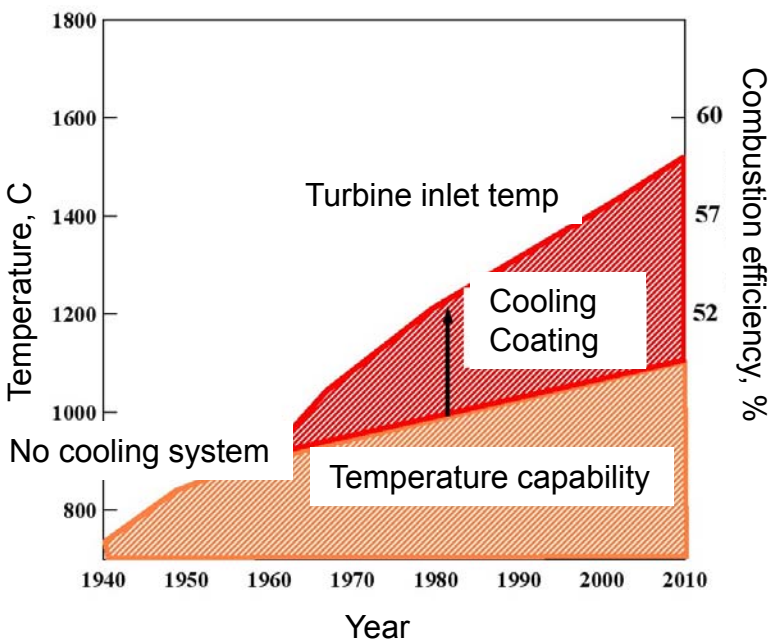


Improvement of temperature capability！

Conventional research

Improvement of temperature capability
Weight saving of materials
Ni-base superalloys（melting temp:1300℃）
→Materials limitation
Other Metals, Nb(2470℃), Ir（2443℃）:
Disadvantage for weight, strength,
oxidation resistance, workability etc

Limitation！

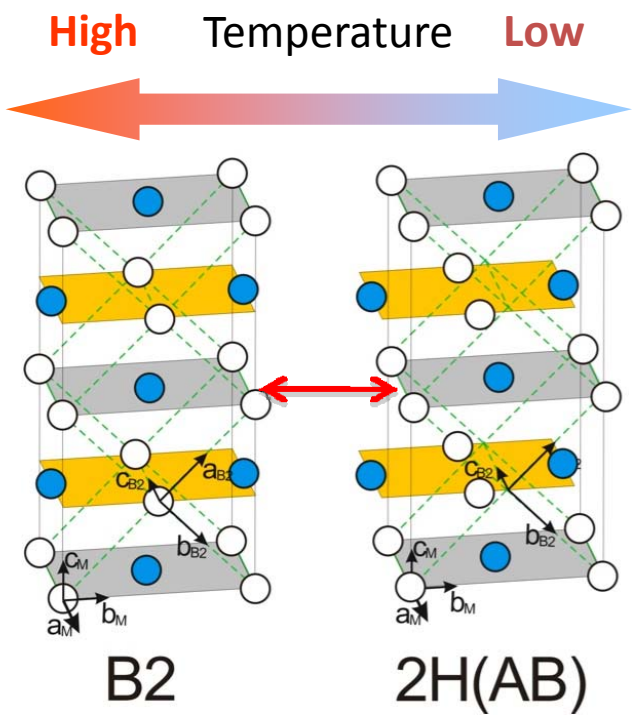
New trials

Controlling of gas leakage

Clearance controlling

Shape memory alloys

Allotropic transformation
- diffusionless
- military movement of atoms

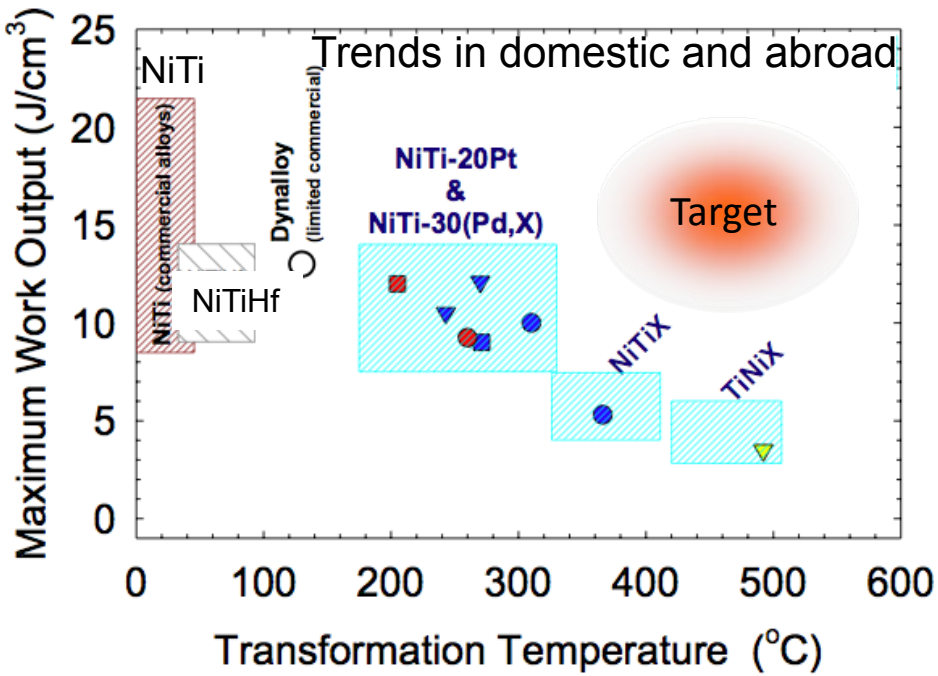


Shape memory alloys can change their shape by transformation depending on temperature without motor.

Transformation temperature decides Work temperature.

Conventional SMA: TiNi+X

Transformation temp. of TiNi is up to 100℃



Based on compounds with high transformation temp
- Controlling of transformation temp. by a third element
- Microstructure controlling by heat treatment
- Investigation of shape memory effect and mechanical properties
- Development of high-temperature shape memory alloys