YNU Research 002 Wataru Nakao Group

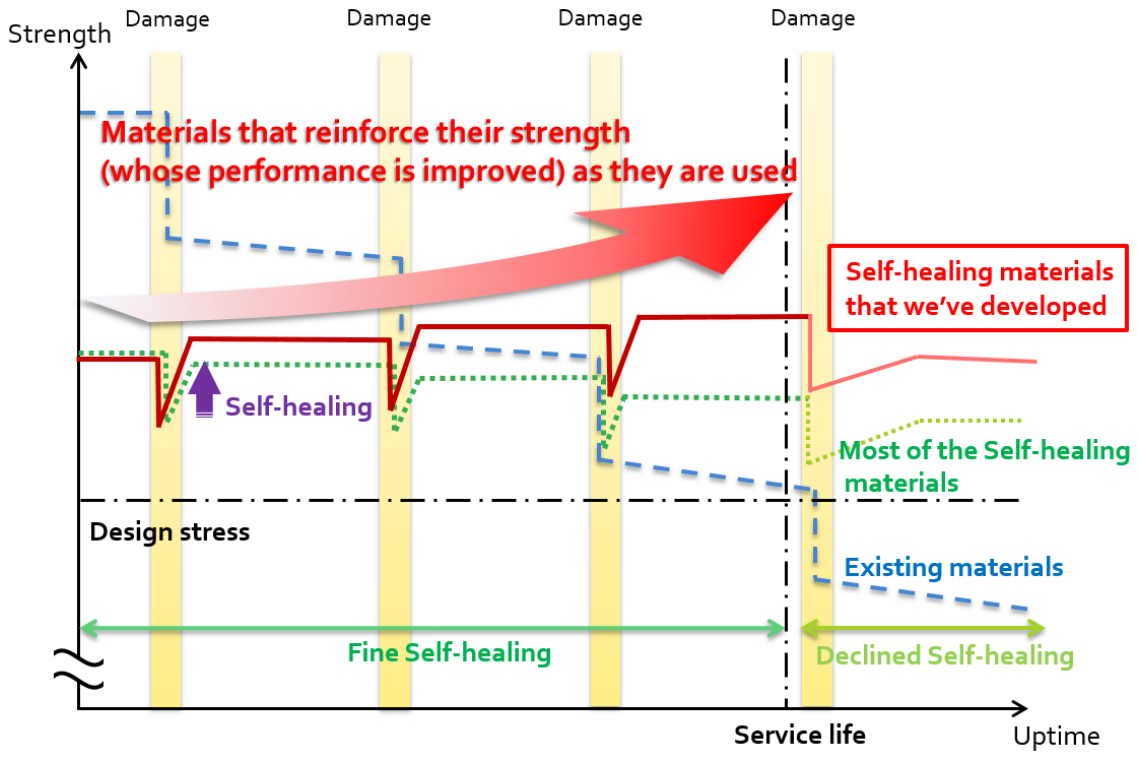
Like bio-living ceramics?

The development of “Fiber-Reinforced Self-Healing Ceramics”

Professor Wataru Nakao’s research group is studying “Fiber-reinforced Self-Healing Ceramics”, which have self-healing function through chemical reaction like the bones of bio-living things. They are vitally dynamic functional copying materials whose features are like ones of bio-living things flexibly corresponding to their own environment.

The development of materials that reinforce their strength as they are used

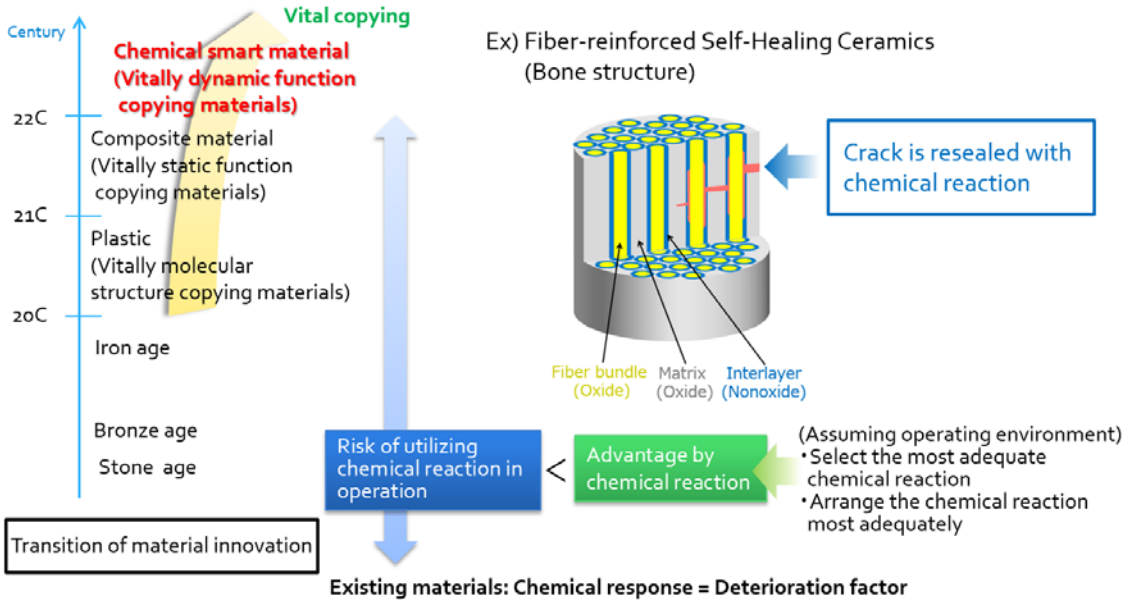
Self-healing materials are materials that heal their own damages caused by exterior impact with chemical reaction as if bio-living things cured their own wounds. The strength of materials so far has been declining little by little during their use, but self-healing materials recover their strength automatically and can retain the reliability during their service life. It is also their merit that their service life can be estimated judging from their use time. Furthermore, materials that professor Wataru Nakao’s research group has developed have features, that their strength of self-healing is stronger than before any damage(crack) has been caused to them.



Potential of making innovation to material designing

By combining the materials whose strength are reinforced that Professor Wataru Nakao's group has developed, the materials so far and the other self-healing materials, they can be led to the strength in accordance with the purpose during their use. This can diminish the high accuracy of product control required at the time of manufacturing and reduce the production cost. Thus, there is a possibility of vitally dynamic functional copying materials being the revolution that can renovate the notion of material designing.

The creation of vitally dynamic functional copying materials utilizing chemical response



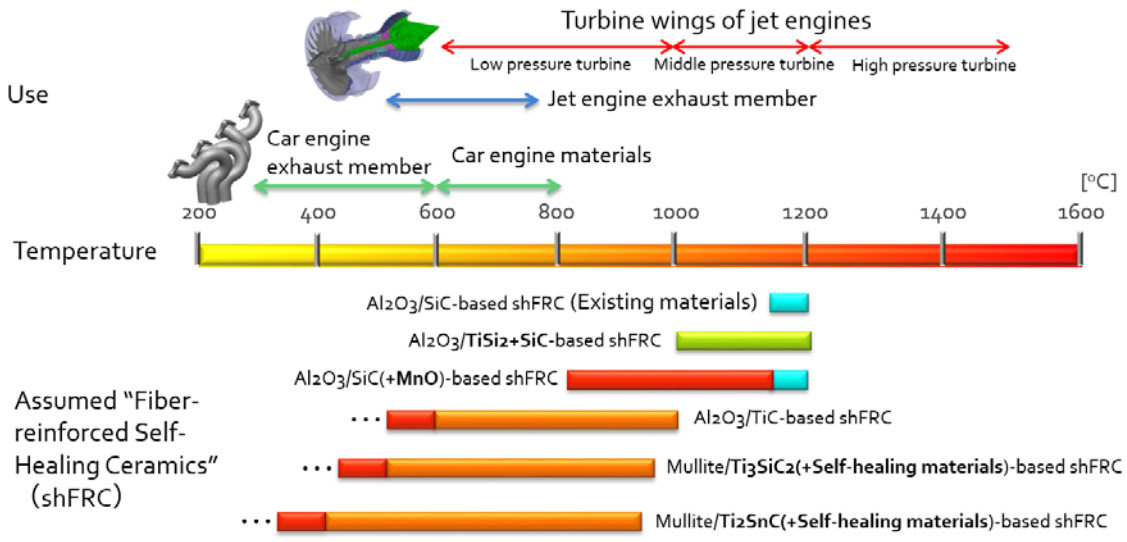
"Fiber-reinforced Self-Healing Ceramics" consists of matrix, fiber bundle, and interlayer. Interlayer is made of nonoxide with low strength, like silicon carbide(Sic). When an exterior impact is applied, a forking crack occurs on the weak interlayer, evading fiber bundles to hinder critical destruction by control. Also, by occurrence of crack, nonoxide faces outer air for the first time, and it transforms into oxidation product with chemical reaction. For example, in case of silicon carbide(Sic) whose oxidation reaction begins at around 1200℃, it transforms into silicon dioxide and increases its volume. It melts with the fever which is generated at the time of oxidation and is weld to surroundings, which restore the crack part, recover the strength of whole ceramics and refine it.

Aiming to implement self-healing materials as turbine blades of jet engines

One of the idea that Professor Wataru Nakao's research group thinks as implementation of "Fiber-reinforced Self-Healing Ceramics" is turbine blades of jet engines. The ceramics weigh less than one quarter of nickel base alloy used at turbine wings, and have excellent heat-resisting property, which enables weight reduction because they don't need cooling equipment, and a large amount of improvement of fuel efficiency can be expected.

On material development, we've exploited various materials which recover the strength completely under the wide range of temperature from 600℃ to 1200℃, which is the material condition required to turbine wings of jet engines, using "Back cast", the method of research development that the present research development is held back from the condition required for future implementation. But to implement it, a lot of surrounding techniques are necessary like exquisite shape manufacturing techniques, mass production techniques.

So, we are proceeding the research of materials which are required for implementation of turbine wings of ceramics jet engines, spreading networks with relative companies and researchers.



Published papers, magazine articles:

1. "High-temperature Bending Strength of Self-healing Ni/Al2O3 Nanocomposites", H. V. Pham, M. Nanko, W. Nakao, *International Journal of Applied Ceramic Technology*, Vol. 13, Issue 5, 973-983, (July 2016)
2. "Methodology for evaluating self-healing agent of structural ceramics", S. Yoshioka, W. Nakao, *Journal of Intelligent Material Systems and Structures*, Vol.26, No.9, 1395-1403, (July 2015)

Related Links:

1. Institute of Advanced Sciences Self-Healing Materials

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