Syllabus

High Temperature Structural Materials

- basic, strengthening mechanisms, and alloy design -

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High temperature materials are used under large stress and severe environment such as oxidation and/or corrosion at high temperature in aerospace, energy related field, and material processing etc. In the introduction, typical strengthening mechanism of alloys for high temperature materials is introduced. At high temperature, materials deform gradually when they are exposed even under low stress. This phenomenon is called creep behavior and governs material's life. General introduction of creep behavior is then shown. Typical high temperature materials such as heat resistance steel, Ni-base superalloys, and Ti alloys, and TiAl are introduced.

Heat-resistant steels are used in wide area such as steam-power generation system, nuclear plants, and petroleum refinery. Heat-resistant steels are generic name from carbon steel to alloy steel. Their operating temperatures are below 600^{o}C for ferrite steel and 700^{o}C for austenite steel. Ni-base superalloys are used in the most severe and high temperature parts in jet engine. Single crystals are used as turbine blades at the back in combustion system to protect materials from deterioration at grain boundary and to obtain enough creep properties. Combustion gas temperature is very high, above melting temperatures of Ni-base superalloys. Ni-base superalloys are exposed under severe oxidation environment. Then, coating to protect from oxidation is also applied to Ni-base superalloys. Ti alloys are used in jet engine, but at lower temperature area in compressor. Ti alloys are divided into several groups, such as α, near α, $\alpha+\beta$ and β alloys. α or near α-Ti alloys are mainly used for such high temperature applications because their structure is hcp. These α -Ti alloys can be used up to 600^{o}C. In this lecture, some aspects and alloy design policy of these alloys are introduced. Recently, the news that intermetallic compounds of TiAl effectively improved the heat efficient of jet engine for Boeing 787 was a popular topic. The advantage and disadvantage of TiAl are also introduced.Finally, high temperature shape memory alloys investigated in NIMS is also introduced as new high temperature alloys.

1. Introduction
2. Heat resistant steel
3. Ni-base superalloys
4. High temperature Ti alloys and TiAl
5. High temperature shape memory alloys