International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

Balapur P.O., Hyderabad – 500005, Telangana, India

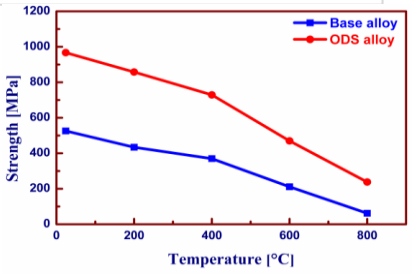
Oxide Dispersion Strengthened Steels for High Temperature Applications

Overview

Oxide dispersion strengthened (ODS) Ferritic-Martensitic/Ferritic/Austenitic steels are endowed with high temperature strength and resistance to creep, fatigue, oxidation and hot corrosion. Hence, these steels are potential candidates for the components in nuclear reactors, gas and ultra super critical steam turbines which are exposed to temperatures up to about 700°C. The high temperature properties of ODS steels are due to the fine grained microstructure, nanosized oxide (Y-Ti-O complex) dispersoids and stability of the microstructure at high temperatures. ARCI has embarked on major programmes for development and demonstration of technologies for the manufacture of blades for ultra super critical steam turbines, clad tubes of fast breeder reactor and high pressure compressor and low pressure turbine blades for gas turbines.

Key Features

- High operating temperature of 650-700°C
- High yield strength and creep resistance
- Potential candidates to replace nickel based super alloys
- Resistance to swelling under irradiation
- Established manufacturing processes



Variation of strength with temperature

Potential Applications

- Blades for ultra super critical steam turbines
- High pressure compressor and low pressure turbine blades of gas turbines
- Clad tubes for nuclear reactors
- Structural materials for fusion reactors
- Other high temperature applications

500 MW first stage ODS steel blade

Technology Readiness Level (TRL): 8

- Established manufacturing processes at pilot plant scale
- Performance and stability are validated at prototype level
- Further evaluation is underway

Clad tube of Fast breeder reactor

IPDI*	1	2	3	4	5	6	7	8	9	10
Activities	*Basic concepts and understanding of underlying scientific principles*	*Short listing possible applications*	*Research to prove technical feasibility for targeted application*	*Coupon level testing in stimulated conditions*	*Check repeatability/ consistency at coupon level*	*Prototype testing in real-life conditions*	*Check repeatability/ consistency at prototype level*	*Reassessing feasibility (IP, competition technology, commercial)*	*Initiate technology transfer*	*Support in stabilizing production*
Status										

IPDI : Intellectual Property Development Indices

Major Patents / Publications

1. S. Santra, S. Amirthapandian, A. J. London, B. K. Panigrahi, R.M. Sarguna, S.Balaji, R.Vijay, C. S. Sundar and C. Grovenor, "Effect of Ti and Cr on dispersion and structure of oxide nano-particles in model ODS alloys", *Acta Mater.* 97 (2015) 223-233.
2. M. Nagini, R. Vijay, Koteswararao V. Rajulapati, K. Bhanu Sankara Rao, M. Ramakrishna, A.V. Reddy and G. Sundararajan, "Effect of process parameters on microstructure and hardness of oxide dispersion strengthened 18Cr ferritic steel", Metall Mater. Trans. A, 47 (2016) 4197-4209.
3. K. Suresh, M. Nagini, R. Vijay, M. Ramakrishna, Ravi C. Gundakaram, A.V. Reddy and G. Sundararajan, "Microstructural studies of oxide dispersion strengthened austenitic steels", Mater. Design, 110 (2016) 519-525.
4. M. Nagini, R. Vijay, Koteswararao V. Rajulapati, A.V. Reddy and G. Sundararajan, "Microstructure-mechanical property correlation in oxide dispersion strengthened 18Cr ferritic steel", *Mater. Sci. Eng. A*, 708 (2017) 451-459.

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