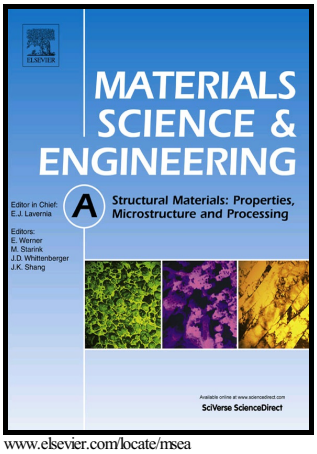
Influence of Laves phase on creep strength of modified 9Cr-1Mo steel

X.Z. Zhang, X.J. Wu, R. Liu, J. Liu, M.X. Yao



www.elsevier.com/locate/msea

PII: S0921-5093(17)31136-X
DOI: http://dx.doi.org/10.1016/j.msea.2017.08.111
Reference: MSA35459

To appear in: *Materials Science & Engineering A*

Received date: 15 July 2017
Revised date: 29 August 2017
Accepted date: 30 August 2017

Cite this article as: X.Z. Zhang, X.J. Wu, R. Liu, J. Liu and M.X. Yao, Influence of Laves phase on creep strength of modified 9Cr-1Mo steel, *Materials Science & Engineering A,* http://dx.doi.org/10.1016/j.msea.2017.08.111

Influence of Laves phase on creep strength of modified 9Cr-1Mo steel

X.Z. Zhang[a], X.J. Wu[b], R. Liu[a,*], J. Liu[a], M.X. Yao[c]

[a] *Department of Mechanical and Aerospace Engineering, Carleton University, Ottawa, ON, K1S 5B6, Canada*

[b] *Structures and Materials Performance Laboratory, Institute for Aerospace Research, National Research Council Canada, Ottawa, ON, K1A 0R6, Canada*

[c] *Kennametal Stellite, Belleville, ON, K8N 1G2, Canada*

Abstract

The influence of Laves phase in the microstructure on the creep strength of a modified 9Cr-1Mo tempered ferritic steel, F91, is investigated in this research. Through additional aging heat treatment up to 5,000 hours, a pronounced increase of Mo-rich Laves phase is found around Cr-rich carbide $M_{23}C_6$, which is pinned on the prior-austenite grain boundaries and martensitic lath boundaries. This secondary precipitation hardening provided by the Laves phase is rapidly offset by its coarsening into large clusters during long-term thermal exposure and under creep conditions, leading to earlier creep rupture than the pristine material. Uniaxial constant-load creep tests are conducted on both aged and non-aged coupons under the same creep conditions. The creep rupture behaviour of both materials is rationalized with the assistance of a deformation-mechanism-based true-stress creep model that was developed in the previous work. The effects of Laves phase on the creep strength of F91 are related to its influence on the well-recognized existing deformation mechanisms: dislocation glide, dislocation climb, and grain boundary sliding.

Keywords: Laves phase, Modified 9Cr-1Mo steel, Creep, Deformation-mechanism-based model, Heat treatment