Characterization of corrosion evolution and mechanical properties of T91 steel exposed to static liquid lead-bismuth eutectic at 500 °C

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Fracture Fatigue and Wear

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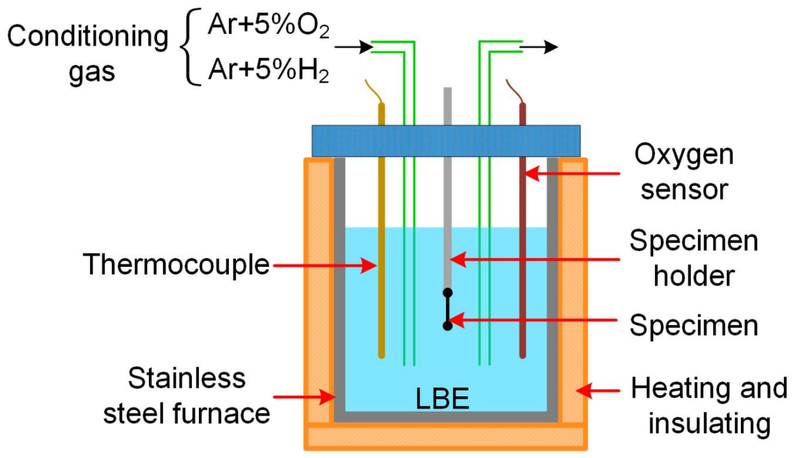
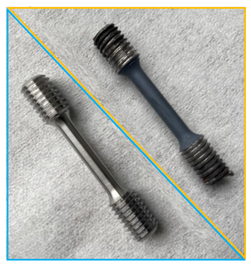
INTRODUCTION

Lead-bismuth eutectic (LBE) has been considered a promising candidate for the coolant of Lead-cooled fast reactor. However, the compatibility between structure materials and LBE remains a major issue of the reactor systems. Structure materials suffer from severe corrosion when exposed to liquid LBE, which may cause a big amount of loss to the durability of structures. To ensure good long term performance, corrosion mechanism and effect of corrosion on mechanical properties of T91 steels in liquid LBE have to be thoroughly investigated.

EXPERIMENTAL



Schematic of static corrosion facility



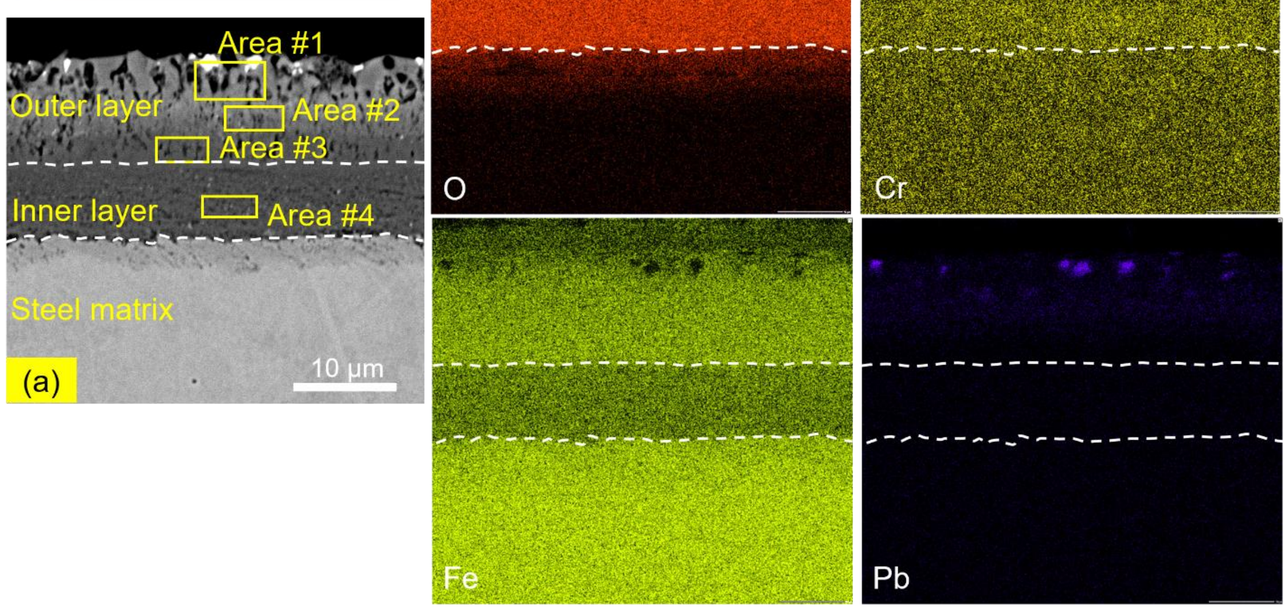
After corrosion

Before corrosion

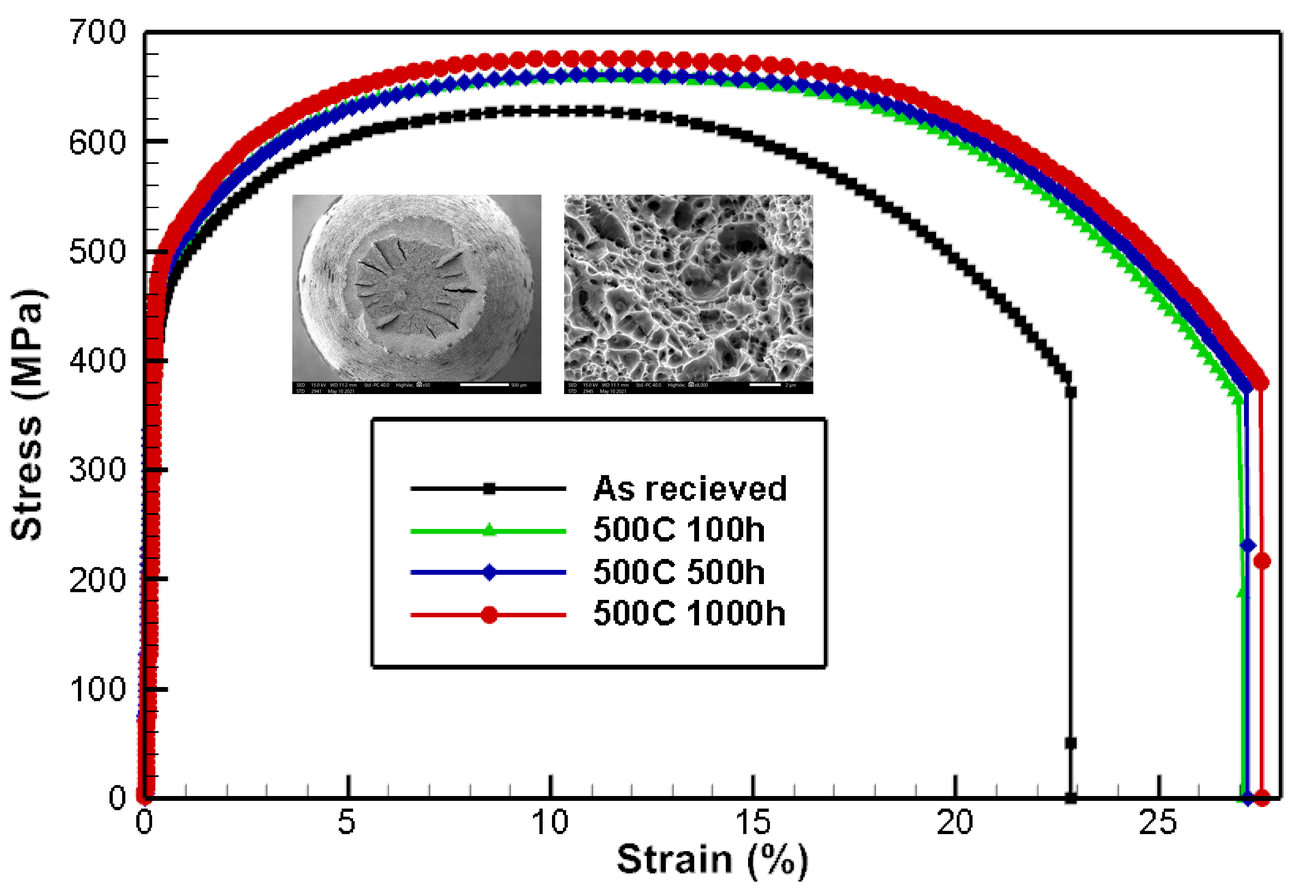
Material: T91 steel, LBE
Temperature: 500 °C
Oxygen concentration: saturated
Measurements: SEM, EDS, Nano-indentation, Quasi-brittle tension

RESULTS AND DISCUSSION

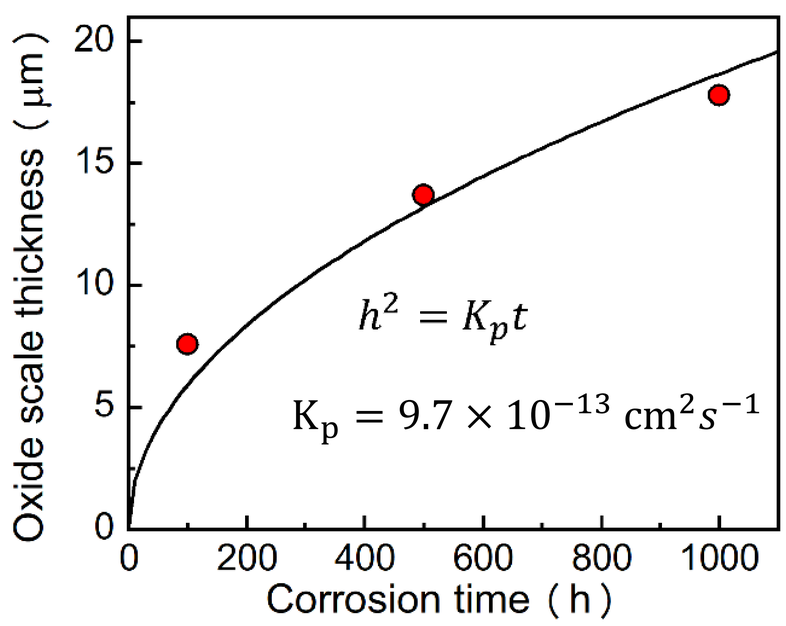
EDS Analysis of duplex oxide scale (after 1,000 h exposure to LBE)



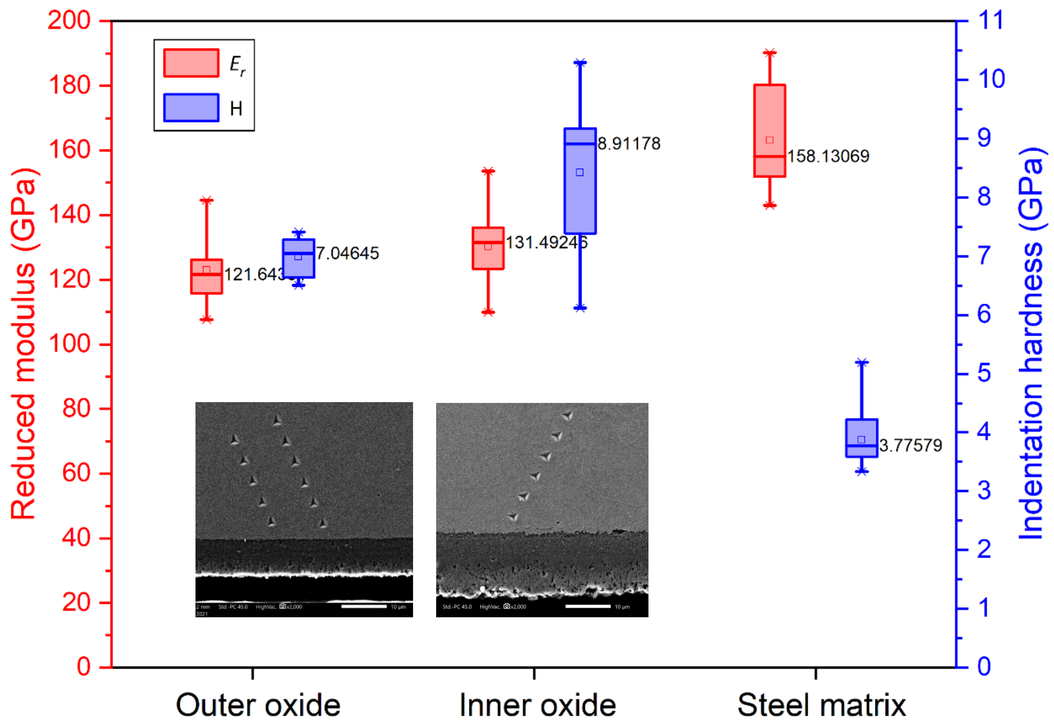
(b) Atomic fraction (%)	O	Cr	Fe	Pb
Area #1	61.96	0.22	35.55	1.42
Area #2	59.21	0.30	39.47	1.02
Area #3	58.64	1.01	40.21	0.14
Area #4	57.91	9.17	32.92	-



Tension behavior of T91 steels after exposure to LBE



Parabolic law fitting of the oxide scale growth



Nano-indentation results of the material T91.

CONCLUSIONS

- ❑ Duplex oxide scales form on the T91 steel surfaces after exposure to the oxygen-saturated LBE.
- ❑ Oxide layers have a higher hardness, while a smaller modulus, than those of the steel matrix.
- ❑ Both ultimate strength and strain to failure show an increase after exposure to the oxygen-saturated LBE.