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Creep behavior of concentrated solid solution alloys

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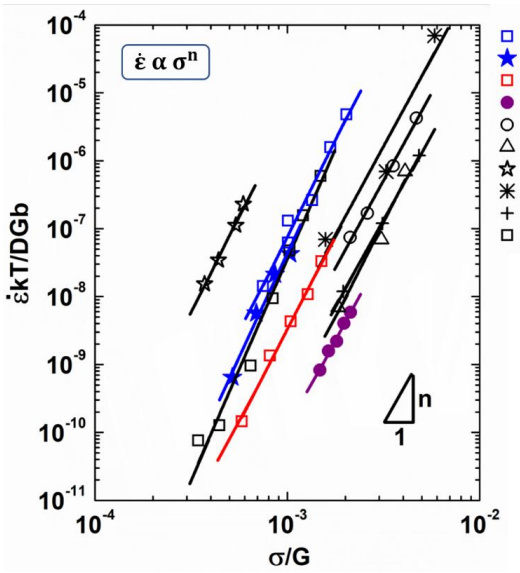
Concentrated solid solution alloys (CSSAs) are one of the exciting fields in the materials community owing to their superior mechanical properties. Among several CSSAs, several studies have been carried out on the Cantor alloy (NiCoCrFeMn), but there is a substantial scatter in the creep data within a narrow temperature range, as shown in Fig.1 [1]. To capture the effect of solute elements on the creep behavior, 2 sub-systems (Ni – 33 Co and NiCoCrFe) of the Cantor alloy were studied here. The alloys (single phase face centered cubic solid solution) were produced from the melting route and further subjected to cold rolling and recrystallization treatment to obtain a grain size of ≈ 100 µm. The twin boundary fraction in both recrystallized and crept conditions was higher in the NiCoCrFe alloy compared to the Ni – 33 Co alloy. Both the alloys showed dislocation climb as the dominating deformation mechanism, with a stress exponent $n \approx 5$. The creep rate of 4 elemental CSSA is the lowest among all observed Ni-based CSSAs (Fig.1). Electron channeling contrast imaging (ECCI) of crept samples revealed well developed cell structure formation in Ni – 33 Co alloy at high stresses, whereas only a random distribution of dislocations and band structure was noted in NiCoCrFe alloy.



Alloy	T (K)	d (µm)	n
Ni - 30 Co (1981)	923	≈ 100	5.7 ± 0.4
Ni - 33 Co (present)	975	100	6.1 ± 0.6
NiCoCr (2020)	973	149	5.5 ± 0.2
NiCoCrFe (present)	990	100	5.2 ± 0.5
NiCoCrFeMn (2014)	1023	12	5.1 ± 0.2
NiCoCrFeMn(2015)	1173	≈250	5.6 ± 0.9
NiCoCrFeMn (2018)	923	22	5.8 ± 0.3
NiCoCrFeMn (2018)	1173	-	5.2 ± 1.3
NiCoCrFeMn (2019)	1248	419	5.1 ± 0.1
NiCoCrFeMn (2018)	973	0.8	6.5 ± 0.4

Fig.1 Comparison of the creep data of Ni based CSSAs

Keywords: Solid solution alloys; Creep; Electron channeling contrast imaging

References:

[1] Kang, You Bin, et al., Dislocation creep behavior of CoCrFeMnNi high entropy alloy at intermediate temperatures, Materials Research Letters, 6, 2018, 689-695.