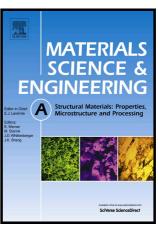
Author's Accepted Manuscript

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www.elsevier.com/locate/msea

PII: S0921-5093(18)30400-3

DOI: https://doi.org/10.1016/j.msea.2018.03.053

Reference: MSA36246

To appear in: Materials Science & Engineering A

Received date: 31 January 2018 Revised date: 10 March 2018 Accepted date: 13 March 2018

Cite this article as: Qin Shen, Xiangyuan Xiong, Tong Li, Hao Chen, Yangming Cheng and Wenqing Liu, Effects of co-addition of Ni and Al on precipitation evolution and mechanical properties of Fe-Cu alloy, *Materials Science & Engineering A*, https://doi.org/10.1016/j.msea.2018.03.053

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ACCEPTED MANUSCRIPT

Effects of co-addition of Ni and Al on precipitation evolution and mechanical

properties of Fe-Cu alloy

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ABSTRACT Fe-Cu and Fe-Cu-Ni-Al alloys were aged at 500 °C for different time

after solution treatment at 900 °C for 2 h. The influence of co-addition of Ni and Al

on the microstructure evolution of Cu-rich phase was studied using atom probe

tomography (APT). APT results showed that the addition of Ni and Al effectively

increased the number density of Cu-rich particles and reduced their sizes with a

narrow size distribution. In the peak hardness condition, the precipitates in the

Fe-Cu-Ni-Al alloy exhibited a core-shell structure with the Cu-rich phase in the core

and NiAl phase in the outer shell, leading to a dramatic improvement of peak

hardness and strength. The NiAl shell of the precipitates impeded the growth and

coarsening of the Cu-rich phase by decreasing the interfacial energy and the diffusion

rate of Cu, Ni and Al atoms in the shell. After further ageing, the core-shell structure

of the precipitates decomposed, forming separate Cu-rich phase and NiAl phase.

KEY WORDS Cu-rich phase, Precipitation hardening, Atom probe tomography

Fe-Cu-Ni-Al alloy, Ageing

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1. Introduction

Cu precipitation strengthening in steels has been studied extensively and has

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