Accepted Manuscript

The coupling effect of size and damage in micro-scale metallic materials

Haoxuan Ban, Yin Yao, Shaohua Chen, Daining Fang

PII: S0749-6419(16)30267-4

DOI: 10.1016/j.ijplas.2017.04.012

Reference: INTPLA 2190

To appear in: *International Journal of Plasticity*

Received Date: 2 November 2016

Revised Date: 17 March 2017

Accepted Date: 15 April 2017

Please cite this article as: Ban, H., Yao, Y., Chen, S., Fang, D., The coupling effect of size and damage in micro-scale metallic materials, *International Journal of Plasticity* (2017), doi: 10.1016/j.ijplas.2017.04.012.

The coupling effect of size and damage in micro-scale metallic materials

Haoxuan Ban[1] **Yin Yao**[2] **Shaohua Chen**[2,*] **Daining Fang**[2]

[1] *LNM, Institute of Mechanics, Chinese Academy of Sciences, Beijing, 100190, China*

[2] *Institute of Advanced Structure Technology and Beijing Key Laboratory of Lightweight Multi-functional Composite Materials and Structures, Beijing Institute of Technology, Beijing, 100081, China*

Abstract

In order to characterize the deformation behavior accompanying damage of microstructures in micro-scale metallic materials, a new theoretical model is developed based on a low order strain gradient plasticity theory. Not only the size effect induced by strain gradient plasticity but also the one of microstructure damage induced by deformation is considered. The feature of the new theory includes two aspects: the strain gradient is taken as an internal variable to affect the tangential hardening modulus without the introduction of high-order stress or high-order boundary condition; both the elastic modulus and the involved intrinsic length are influenced by the microstructural damage. Two commonly used samples with size effect in micro-scales, i.e., the thin wire torsion and the ultra-thin beam bending, are re-analyzed with the new model. It is found that stiffness of the micro-scale material is gradually reduced along with the increasing deformation and the theoretical prediction is consistent well with the existing experimental data. All the results demonstrate that the present theory should be a promising way for predicting the

[*] Corresponding author. chenshaohua72@hotmail.com or shchen@bit.edu.cn, Tel.: 86-10-68913927.