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STRAIN LOCALIZATION ANALYSIS OF HEXAGONAL METAL BASED ON HOMOGENIZATION METHOD

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ABSTRACT

Polycrystalline metals have the multiscale structure and material properties of them are strongly affected by their microstructure such like crystalline aggregate. Recently, therefore, multiscale simulations considering crystalline scale structures are actively studied and one of the models, which can describe microscale behaviors of metals, is the polycrystalline plasticity. One of the conventional ways to represent the polycrystalline behaviors is the Taylor model which is also extended to a large strain and rate-dependent material by Asaro and Needleman [1]. On the other hand, from the viewpoint of numerical method, the homogenization method is one of the powerful procedures to combine behaviors in a macroscale and a microscale with a periodical structure satisfying physical and mathematical compatibility between those scales. Additionally, it can evaluate the homogenized macroscopic material properties only from the microstructure information.

Most of industrial metals have face-centered cubic (FCC), body-centered cubic (BCC) or hexagonal close-packed (HCP) structure as the crystal lattice. In many of the past studies based on the polycrystalline plasticity, they focused on FCC metals and few have an interest in HCP like titanium or magnesium [2]. Plastic formability of HCP metal has disadvantage comparing with FCC or BCC because HCP has few number of slip systems, typically three on the early stage of deformation at room temperature. To improve the formability of HCP, the development of a numerical procedure based on the multiscale modeling is expected.

The author introduced a three-dimensional polycrystalline model into the homogenization method and investigated the effects of adoption of unit cell on the macroscale behaviors with the polycrystalline homogenization method. The analyses are mainly applied to HCP metals. The results are compared with those of the extended Taylor model and the advantages of the present approach were shown [3]. Based on the knowledge of the previous work, in this study, a multiscale coupled analysis scheme based on the homogenization method is utilized for HCP materials. A macroscopic necking behavior caused by strain localization is analyzed and the effects of microstructures on the macroscopic strain localization are discussed.

REFERENCES

[1] R.J. Asaro, A. Needleman, "Texture Development and Strain Hardening in Rate Dependent Polycrystals", *Acta Metall.*, Vol. **33**, pp. 923-953, (1985).

[2] P.R. Dawson, E.B. Marin, "Mechanics of Metal Deformation Processes Using Polycrystal Plasticity", *Adv. Appl. Mech.*, Vol. **34**, pp. 77-169, (1998).

[3] Y. Tadano, M. Kuroda, H. Noguchi, K. Shizawa, "A Polycrystalline Analysis of Hexagonal Metal Based on the Homogenized Method", *Key Engineering Materials*, Vol. **340-341**, pp. 1049-1054, (2007).