The influence of electron radiation on the mechanical properties of geopolymers

*Yaru Yang[1], Hisayuki Suematsu [1], Isamu Kudo[2,3], Thi-Mai-Dung Do[1], Thi-Chau-Duyen Le[1],
Tadachika Nakayama[1] and Koichi Niihara[1]
[1]Extreme Energy-Density Research Institute, Nagaoka University of Technology
[2] Technology Development Center, Nagaoka University of Technology
[3]ADVAN ENG. Co., ltd.

Abstract

After the decommissioning of JMTR, the geopolymer treatment method for difficult waste ion exchange [1]. The potassium and metakaolin-based geopolymer is irradiated by ETIGO-III at room temperature from one to four shots. The Vickers hardness were decreased after irradiation but did not affect by the number shots. The current results show the stability of metakaolin-based geopolymers under electron irradiation.

Introduction

With the development of the nuclear industry, there are inevitable problems of nuclear power plant abandonment and nuclear waste disposal. The disposal of some radioactive metal ions has not yet been well solved. Geopolymers are inorganic polymers composed of AlO_4 and SiO_4 tetrahedral structural units and a three-dimensional network structure [2], This structure is very conducive to dividing and enclosing metal ions and other toxic substances in the cavity; at the same time, the aluminum ions in the framework can also adsorb metal ions [3]. It can be applied to nuclear waste treatment [4], catalysis, adsorption, and other fields. The stability of geopolymer under irradiation is important.

Experiment

Geopolymer samples were made of AFACO silica, metakaolin powder, potassium hydroxide and potassium silicate solution with molar ratios of Al: Si: K: H_2O =1: 2.1: 0.8: 8. The potassium silicate, potassium hydroxide powders and the distilled water were mixed. The solution was stirred until complete dissolution of the powder. Then, the solution was cooled to room temperature with an ice bath. EFACO silica powder was added to the solution, stirred for 1 minute, and then metakaolin was added. Finally, the slurry was totally stirred for 10 minutes to synthesize a geopolymer sample. Samples were cured at 60 ℃ from 1 to 4 days with lid respectively, then demolded and moved to RT until the 14 days. The potassium and metakaolin-based geopolymer was irradiated by ETIGO-III at a peak voltage 2Mev, and a pulse with of 100 μs from one to four shots. The Vickers hardness of geopolymer samples was measured after ground and polished by a diamond paste to become mirrors. Vickers indenter was loaded at 1 kgf for 15 s with 12 measurements for every sample to analyze Vickers hardness.

Results and Discussion

The Vickers hardness (as shown in Fig.1) decreased after the irradiation but did not affect by the number of shots. The stability under ionizing radiation indicates that geopolymers have the potential for processing nuclear waste metal ions.

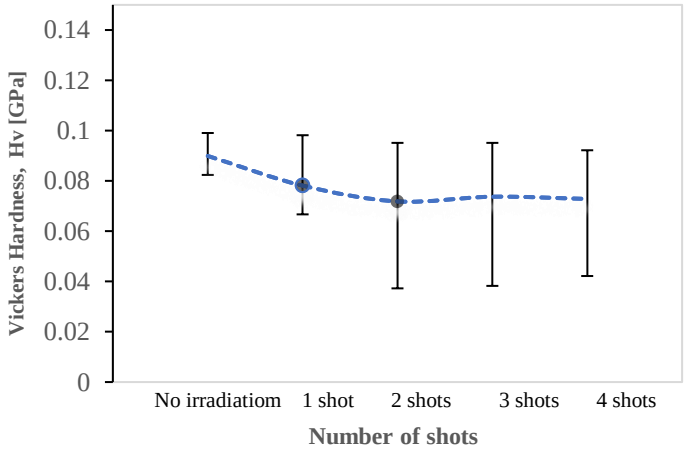

Fig. 1 Vickers hardness

Keywords: Geopolymer, irradiation, ion- exchange, hardness

References

[1] S. Misaki, et al. Dekomisshoningu Giho, p.9 – 19

[2] Roy, D.M., New strong cement materials: chemically bonded ceramics. Science, 1987. 235(4789): p. 651-8.

[3] Chindaprasirt, P, et al. Workability and strength of coarse high calcium fly ash geopolymer. Cement and Concrete Composites, 2007. 29(3).

[4] Gao, X.X., et al., Behavior of metakaolin-based potassium geopolymers in acidic solutions. Journal of Non-Crystalline Solids, 2013. 380: p. 95-102