# Hardness in Electron Irradiated Metakaolin Based Geopolymer

*Thi-Chau-Duyen Le[1], Hisayuki Suematsu[1], Isamu Kudo[2,3], Thi-Mai-Dung Do[1], Tadachika Nakayama[1], and Koichi Niihara[1]

[1]*Extreme Energy and Density Research Institute, Nagaoka University of Technology*

[2]*ADVAN ENG. co.,ltd* [3]*Technology Development Center, Nagaoka University of Technology*

**Abstract**

Metakaolin based geopolymer was irradiated at room temperature by a DC electron accelerator. Up to 1 MGy, the hardness was not changed remarkably. The present results indicate the stability of metakaolin based geopolymer for applications in hydrogen recombination catalyst supports.

Keywords: geopolymer, irradiation, hardness.

## 1. Introduction

After the Fukushima Daiichi Nuclear Power Plant accident, the radioactive slurry is generated and will be stored in containers. In a stable storage of the radioactive slurry, the radiolysis may cause a hydrogen explosion. In aims to control the generated hydrogen, a recombination catalyst which should be developed at low cost and stable over a long period of time is required. To meet this demand, novel hydrogen catalysts with known convection properties are being developed [1]. One of candidate supports for the catalyst is geopolymer, which has been developed for nuclear waste containment applications [2]. In this work, crack-free geopolymer samples were synthesized successfully and irradiated by the continuous electron beam accelerator to investigate the effect of irradiation on the hardness of samples.

## 2. Experimental

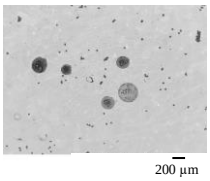
Metakaolin and potassium based geopolymers with molar ratio Al:Si:K:$H_2O$= 1:2:1:8 were fabricated. At first, potassium silicate solution, deionized water, and potassium hydroxide were mixed. Then, metakaolin and micro silica powders were mixed with the above solution for 4 minutes. The slurry was poured into a polypropylene cylindrical cup. The geopolymers were cured at $40^0$C with a cap for 5 days, demolded on the $7^{th}$ day and put in the ambient atmosphere until the $28^{th}$ day.

The 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.

Irradiation test by the continuous electron beam accelerator at Takasaki, JAEA with an energy of 2 MeV and a current of 0.2 mA.

## 3. Results and Discussion

(a)




(b)

Fig. 1. Body (a) and SEM (b) photograph of samples.

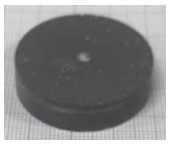


Fig. 2. Cut sample after polishing.

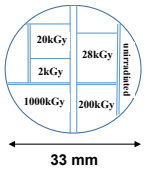



Fig. 3. Cutting sample into 6 parts.

Table 1. Relation of the irradiation time and absorption dose.

| Dose (kGy) | 2 | 20 | 28 | 200 | 1000 |
|---|---|---|---|---|---|
| Time (s) | 7 | 70 | 98 | 699 | 3497 |

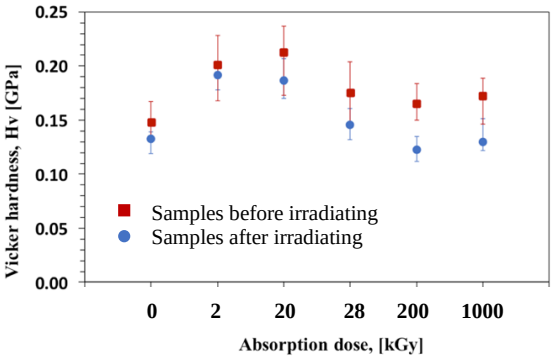



Fig. 4. Vickers hardness before and after irradiating.

It is observed from Fig. 1 that there was no crack on the geopolymer sample with a composition of 1:2:1:8. This best sample was cut into a thickness of 10 mm from the bottom and polished (Fig. 2). After that, it was cut into 6 parts for irradiation (Fig.3). Table 1 shows the irradiation time of every absorption dose from 2 to 1000 kGy.

Figure 4 reveals the Vickers hardness of samples before and after the irradiating. As can be seen from the graph the cut samples before irradiating have different hardness values. The hardness of all samples decreased slightly after irradiation, but within the error bars except for 200 kGy. Therefore, the continuous beams did not affect significantly on the hardness of these geopolymer samples.

## 4. Conclusions

In this study, the crack free geopolymer samples with molar ratio Al:Si:K:$H_2O$= 1:2:1:8 were irradiated with a continuous electron beam to investigate the effect of irradiation on the hardness of geopolymer samples. The hardness of samples was changed negligibly. The pulsed electron beams with various absorption doses will be applied on the same molar ratio samples to compare with the result of the continuous electron beam.

**References**

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