Direct reduction of uranium oxide(U_3O_8) by Li metal and U-metal(Fe, Ni) alloy formation in molten LiCl medium

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1. Introduction

Molten salt based electrochemical processes are proposed as a promising method for the future nuclear programs and more specifically for spent fuel processing. The lithium reduction has been introduced to convert actinide oxides into corresponding actinide metal by using lithium metal as a reductant in molten LiCl medium.[1] We have applied similar lab-scale experiments to reduce uranium oxide in an effort to gain additional information on rates and mechanisms.

2. Experimental and Results

In our experiment, the net reaction can be expressed as follows:

$U_3O_8 + 16Li \rightarrow 3\,U + 8Li_2O$

2.1 Experimental

Figure 1 schematically describes the lab-scale lithium reduction process and monitoring device.

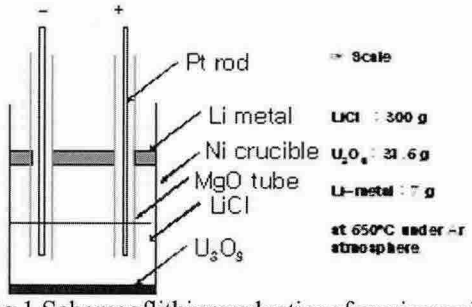

Fig.1.Schemeoflithiumreductionofuraniumoxideinthemoltensalt.

2.2 Monitoring of the process (rates of reaction)

In order to get information on the rate of the reaction, we have applied conventional wet chemical analysis of Li_2O (reaction product). Also, we have developed in-line monitoring method by applying chronoamperometric technique.[2] The results show that more than 90 % of uranium oxide has been reduced to metallic uranium within 10 hours. [3]

2.3 Formation of Uranium-metal(Fe, Ni) Alloy

An interesting finding from our experiment is formation of uranium-metal alloy at relatively low temperature (~650 °C). The reduced uranium forms U-Fe alloy when contacting with stainless steel crucible. U-Ni alloy formation was also found using Ni crucible at the same conditions. XRD and XAS (X-ray absorption spectroscopy) data confirm the formation of U-metal (Fe, Ni) alloy formation. Figure 2 shows the XRD evidence of U-Ni Alloy formation.

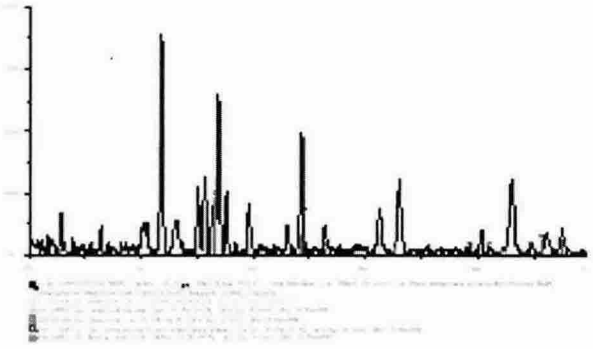

Fig.2.X-raydiffractogramofreduceduraniumproducedbylithiumreductionprocess.

3. Conclusion

Experiments on the direct reduction of uranium oxide (U_3O_8) by so called 'lithium reduction process' have been carried out on a lab-scale in molten LiCl medium (~650 °C). The process was monitored by conventional chemical analysis and in-line electrochemical method. More that 90% of the uranium oxide has been reduced to metallic form within 10 hours. It was found that the reduced uranium forms U-metal (Fe, Ni) alloys at ~ 650 °C in molten LiCl medium.

REFERENCES

[1] T. Usami , M. Kurata , T. Inoue, H.E. Sims, S.A Beetham., J.A. Jenkins, "Pyrochemical reduction of uranium dioxide and plutonium dioxide by lithium metal". *J. Nuclear Materials*. **300**, 15-26. (2002)

[2] In-Kyu Choi, et al. "Method of in-situ monitoring a reduction of uranium oxide by lithium metal" Korean Patent 2004-2054, Date of Patent January,12 , 2004. US and Japan Patent in process.

[3] In-Kyu Choi, et al. to be presented "Determination of reduction yield of lithium metal reduction process', *Proceedings of Korea Nuclear Society Autumn Meeting* , Yong-Pyung, October (2004)