A Study on Decontamination of TRU, CO, AND MO Using Plasma Surface Etching Technique

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Abstract

Recently dry decontamination/surface-cleaning technology using plasma etching has been focused in the nuclear industry. In this study, the applicability and the effectiveness of this new dry processing technique are experimentally investigated by examining the etching reaction of UO_2 , Co, and Mo in r.f. plasma with the etchant gas of CF_4 /O_2 mixture. UO_2 is chosen as a representing material for uranium and TRU (TRans-Uranic) compounds and metallic Co and Mo are selected because they are the principal contaminants in the spent nuclear components such as valves and pipes made of stainless steel or inconel. Results show that in all cases maximum etching rate is achieved when the mole fraction of O_2 to CF_4 /O_2 mixture gas is 20 %, regardless of temperature and r.f. power. In case of UO2 , the highest etching reaction rate is greater than 1000 monolayers/min. at 370 ℃ under 150 W r.f. power which is equivalent to 0.4 μm/min. As for Co, etching reaction begins to take place significantly when the temperature exceeds 350 ℃. Maximum etching rate achieved at 380 ℃ is 0.06 ㎛/min. Mo etching reaction takes place vigorously even at relatively low temperature and the reaction rate increases drastically with increasing temperature. Highest etching rate at 380 ℃ is 1.9 ㎛/min. According to OES (Optical Emission Spectroscopy) analysis, primary reaction seems to be a fluorination reaction, but carbonyl reaction may assist the dominant reaction, especially in case of Co and Mo. Through this basic study the feasibility and the applicability of plasma decontamination technique may be demonstrated. Future works have been planned and thus more fundamental and practical studies will be carried out.