日本化学会 第102春季年会 (2022)

Complete Decomposition of Fluoropolymer ETFE Using Subcritical Water with Potassium Permanganate

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Keywords: Subcritical water; Fluoropolymer; Decomposition; Potassium permanganate

Fluoropolymers have many unique properties such as heat resistance, chemical resistance, weather resistance, and so forth. Therefore, they have been used in various applications. However, their waste decomposition treatment technologies have not yet been well established. If these wastes can be decomposed into fluoride ions (F^-) (i.e. mineralization) under mild conditions, fluorine element can be recycled. Among fluoropolymers, poly(ethylene-*co*-tetrafluoroethylene) (ETFE) copolymer is used in various applications such as piping/valves for chemical plants, tanks, and photovoltaic power generation modules. In this study, the decomposition of ETFE by use of subcritical water and potassium permanganate was investigated.[1)]

Figure 1 shows the $KMnO_4$ concentration dependence of the amounts of F^- in the reaction solution and CO_2 in the gas phase, where ETFE was reacted at 320 ºC for 6 h under argon. When the reaction was carried out in the absence of $KMnO_4$, the F^- yield was 1%, and the CO_2 yield (based on the carbon atom amount in initial ETFE) was 2%. That is, ETFE was little mineralized. In contrast, when aqueous $KMnO_4$ was added, the amounts of F^- and CO_2 increased with increasing $KMnO_4$ concentration. When the $KMnO_4$ concentration was increased to 52.7 mM, the F^- yield reached 92% and CO_2 yield reached 73% (averages of two reactions). Somewhat lower CO_2 yield is due to pH (7.9) of the resulting solution, where the formed CO_2 presents not only in the gas phase but also in the reaction solution as the form of HCO_3^-. Consistently, the remaining ratio of total organic carbon (TOC) in the reaction solution was 4%. Therefore, the majority of fluorine and carbon contents in ETFE were mineralized.

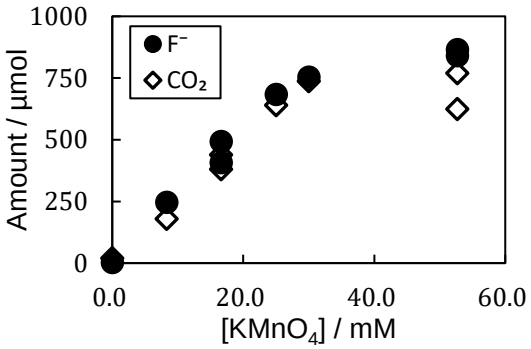

Fig. 1. Effect of $KMnO_4$ concentration on the formations of F^- and CO_2. Reactions were performed at 320 ºC for 6 h. The charged ETFE amount was 30 mg (the fluorine atom amount was 925 μmol and the carbon atom amount was 952 μmol) and the reaction solution volume was 30 mL.

1) H. Hori, J. Hamaura, *Polym. Degrad. Stab*. **2021**, *190*, 109621.