Proceedings of the 2nd World Congress on Recent Advances in Nanotechnology (RAN'17)
Barcelona, Spain – April 4 – 6, 2017
Paper No. ICNNFC 112
ISSN: 2371-5308
DOI: 10.11159/icnnfc17.112

Activity Test with Various AlF_3 Nano-Structure for Catalytic Hydrolysis of NF_3

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Extended Abstract

Fluorine compounds have been highlighted as a warming gas caused the global warming. These Fluorine compounds, such as NF_3, etc., are commonly emitted from semiconductor and LCD manufacturing industries. This study gave assessment of catalytic hydrolysis for the effective decomposition of NF_3 [1, 2]. AlF_3 nano-structures with various morphologies, which were synthesized by various synthesis methods, were used as the catalyst for the hydrolysis of NF_3. AlF_3 with a nano-needle type was synthesized by a gas-solid reaction, and AlF_3 with a large-sized rod type was synthesized using the wet chemical method. The catalytic activity tests were carried out in a fixed-bed reactor, and the content of NF_3 and GHSV were fixed to 5000 ppmv, and 15000 h^{-1}, respectively. Steam was injected at a volumetric ratio of NF_3 / H_2O = 1 / 3 via syringe pump. The characterization of AlF_3 used as the catalyst for hydrolysis of NF_3 was observed by XRD (X-ray diffraction), SEM (scanning electron microscopy) and BET (Brunauer-Emmett-Teller) surface areas measurements. The AlF_3 structures with various morphologies, such as rod, needle, and spherical types, were observed. The AlF_3 samples of most structures had a very low surface area and their surface area showed no significant difference. On the other hand, the results of the activity tests for the hydrolysis of NF_3 over AlF_3 with different morphologies showed different catalytic activity. The conversion of NF_3 over the spherical type AlF_3 was kept at approximately 30 %. In contrast, the catalytic activity of needle-shaped AlF_3 resulted in 100% NF_3 conversion. The activity was maintained for more than 300 h in the long-term tests. The hexagonal crystal structure of AlF_3 (25.321°, 42.715°, 51.997°, and 58.118° 2θ) was confirmed by XRD analysis of all AlF_3 samples used in this study. The orthorhombic crystal structure of AlF_3 (14.747°, 24.943°, 29.746°, 47.463°, and 52.790° 2θ) was confirmed only on the XRD peak pattern of AlF_3 synthesized by the wet fluorination process. The commercial AlF_3 and AlF_3 nanostructure synthesized by the dry fluorination process exhibited a similar XRD peak pattern, but the peak intensity of the commercial AlF_3 on the XRD peak pattern of the hexagonal crystal structure was higher than that of the other AlF_3 samples. The hexagonal structure of AlF_3 has higher catalytic activity for the hydrolysis of NF_3 than the orthorhombic structure of AlF_3. Although the hexagonal structure of AlF_3 had a high catalytic activity for the hydrolysis of NF_3, the needle-like shaped hexagonal structure of AlF_3 had higher catalytic activity than the other shaped hexagonal structures. The hexagonal structure of AlF_3 has higher catalytic activity for the hydrolysis of NF_3 than the orthorhombic structure of AlF_3. Therefore, the needle-like shaped AlF_3 with high catalytic activity can be prepared by a dry fluorination process.

References

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