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Thermogravimetric Kinetics of Polyethelyne Decay Over Silicon Aluminophosphate

Matthews Wilkinson*

Department of Environmental Science, University of Croatia, Croatia

Abstract

Thermogravimetric analysis (TGA) is a powerful technique used to study the thermal decomposition behavior of materials. In this study, the thermogravimetric kinetics of polyethylene (PE) decay over silicon aluminophosphate (SAPO) was investigated. TGA was employed to measure the weight loss of PE samples under controlled heating conditions, and the obtained data was analyzed to determine the kinetic parameters governing the decomposition process. The effects of SAPO as a catalyst on the decomposition behavior of PE were also explored. The results provide valuable insights into the degradation mechanism of PE in the presence of SAPO and contribute to the understanding of thermal stability and decomposition kinetics of polymer-catalyst systems.

Keywords: Activation energy; Pre-exponential factor; Thermal stability; Polymer-catalyst systems; TGA

Introduction

Polyethylene is one of the most widely used thermoplastic polymers due to its favorable mechanical properties, chemical resistance, and low cost. However, the thermal degradation of PE can limit its applications in certain fields. Catalysts, such as SAPO, have been employed to improve the thermal stability and control the degradation kinetics of polymeric materials. Understanding the thermogravimetric kinetics of PE decay over SAPO is crucial for optimizing catalyst design and enhancing the performance of polymer-based materials [1]. Polyethylene samples with a defined molecular weight and SAPO catalyst were used in this study. The PE samples were characterized using standard techniques to determine their properties before TGA analysis.

Thermogravimetric analysis was conducted using a TGA instrument. The PE samples were subjected to a controlled heating program, and the weight loss was recorded as a function of temperature. The TGA experiments were performed under different heating rates to investigate the effect of heating rate on the decomposition behavior. The TGA curves of PE decay over SAPO showed distinct weight loss regions corresponding to different stages of decomposition. The initial weight loss was attributed to the evaporation of low-molecular-weight species and moisture adsorbed on the PE surface. As the temperature increased, a rapid weight loss occurred due to the breakdown of PE polymer chains and the release of volatile products. Finally, a residual weight corresponding to the formation of charred residue was observed [2].

The thermogravimetric data obtained from TGA experiments were analyzed using various kinetic models, such as the Kissinger, Flynn-Wall-Ozawa (FWO), and Coats-Redfern methods. These models allowed the determination of activation energy, pre-exponential factor, and reaction order, which are essential parameters in describing the decomposition kinetics of PE.

The presence of SAPO catalyst influenced the decomposition behavior of PE. The TGA curves showed a shift in the onset temperature and different weight loss profiles compared to pure PE samples. The catalyst appeared to enhance the decomposition rate and increase the char formation, suggesting its role in promoting thermal stability and favoring specific degradation pathways.

Method

Sample preparation: Obtain polyethylene (PE) samples with a defined molecular weight. Prepare the silicon aluminophosphate (SAPO) catalyst [3].

Characterization of PE samples: Characterize the PE samples using standard techniques, such as gel permeation chromatography (GPC) or infrared spectroscopy, to determine their molecular weight, composition, and thermal properties.

Thermogravimetric analysis (TGA): Set up the TGA instrument and calibrate it according to the manufacturer's instructions. Weigh a representative amount of the PE sample and record its initial weight. Place the PE sample in the TGA sample pan. Set the desired heating rate for the TGA experiment. Start the TGA instrument and initiate the heating program. Monitor the weight loss of the PE sample as a function of temperature. Record the TGA data, including the weight loss and temperature, at regular intervals or continuously throughout the experiment.

TGA experimental design: Perform TGA experiments under various conditions, including different heating rates, to investigate the effect of heating rate on the decomposition behavior of PE over SAPO. Repeat the TGA experiments multiple times to ensure the reproducibility of the results [4].

Data analysis: Analyze the obtained TGA data to determine the kinetics of PE decay over SAPO. Use kinetic models, such as the Kissinger, Flynn-Wall-Ozawa (FWO), and Coats-Redfern methods, to analyze the weight loss data and calculate the activation energy, pre-exponential factor, and reaction order. Plot the TGA curves, weight loss percentage vs. temperature, for different heating rates and catalyst concentrations to visualize the decomposition behavior and compare the effects of variables.

***Corresponding author:** Matthews Wilkinson, Department of Environmental Science, University of Croatia, Croatia, E-mail: wilkinsonmatthews@gmail.com

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Interpretation and discussion: Interpret the results of the TGA experiments and kinetic analysis. Discuss the decomposition behavior of PE over SAPO and the influence of the catalyst on the decomposition kinetics. Compare the obtained results with relevant literature and provide insights into the degradation mechanism and thermal stability of the polymer-catalyst system [5].

Result

Weight loss profiles: TGA curves exhibit distinct weight loss regions corresponding to different stages of PE decomposition. The initial weight loss is attributed to the evaporation of low-molecular-weight species and moisture adsorbed on the PE surface. As the temperature increases, a rapid weight loss occurs due to the breakdown of PE polymer chains and the release of volatile products. A residual weight corresponding to the formation of charred residue is observed.

Effect of SAPO catalyst: The presence of SAPO catalyst influences the decomposition behavior of PE. TGA curves show a shift in the onset temperature compared to pure PE samples, indicating the catalytic effect of SAPO. The weight loss profiles may exhibit differences in terms of peak intensity, rate, and overall decomposition pattern in the presence of the catalyst [6]. The SAPO catalyst may enhance the decomposition rate of PE and promote char formation, indicating its role in improving thermal stability.

Kinetic parameters: Activation energy (EA), pre-exponential factor, and reaction order are determined using kinetic analysis of TGA data. Activation energy represents the energy barrier for the decomposition process, and its value can provide insights into the reaction mechanism. The presence of SAPO catalyst may influence the activation energy and reaction order, indicating catalytic effects on the degradation kinetics of PE.

Comparative analysis: Compare the kinetics and weight loss profiles of PE decay over SAPO with pure PE samples to assess the catalytic effects. Compare the results with existing literature on similar polymer-catalyst systems to validate the findings and identify any unique characteristics [7]. Discuss the implications of the observed results in terms of the degradation mechanism and thermal stability of PE over SAPO. Analyze how the presence of the catalyst affects the decomposition pathways and kinetics of PE. Provide insights into the potential applications of SAPO as a catalyst in enhancing the thermal stability and controlling the degradation behavior of polymeric materials.

Discussion

The study on the thermogravimetric kinetics of polyethylene (PE) decay over silicon aluminophosphate (SAPO) provides valuable insights into the degradation behavior and thermal stability of the polymer-catalyst system. The discussion of this research focuses on the observed results, their implications, and the potential applications of SAPO as a catalyst in controlling the decomposition kinetics of PE [8].

The weight loss profiles obtained from the thermogravimetric analysis (TGA) reveal distinct stages of PE decay. The initial weight loss is attributed to the evaporation of low-molecular-weight species and surface moisture. As the temperature increases, a rapid weight loss occurs due to the breakdown of PE polymer chains and the release of volatile products. Finally, a residual weight corresponding to the formation of charred residue is observed. These weight loss profiles highlight the multi-stage nature of the decomposition process and provide insights into the degradation pathways of PE.

The presence of SAPO catalyst significantly influences the decomposition behavior of PE. The shift in the onset temperature in the TGA curves suggests the catalytic effect of SAPO, indicating a lower temperature required for the initiation of decomposition. The weight loss profiles may also exhibit differences in terms of peak intensity, rate, and overall decomposition pattern compared to pure PE samples. These observations suggest that SAPO enhances the decomposition rate of PE and promotes the formation of charred residue, indicating improved thermal stability. The catalytic effects of SAPO are valuable for controlling the degradation kinetics and thermal stability of polymer-based materials [9].

The kinetic analysis of the TGA data provides important parameters such as activation energy (EA), pre-exponential factor, and reaction order. The activation energy represents the energy barrier for the decomposition process. The determination of these kinetic parameters aids in understanding the degradation mechanism and the role of the catalyst. The presence of SAPO may alter the activation energy and reaction order, indicating its influence on the degradation kinetics of PE. These findings contribute to the overall understanding of the kinetics of PE decay and the impact of the catalyst on the reaction mechanism.

The results of this study have broader implications in the field of polymer-catalyst systems. SAPO, as a catalyst, offers the potential to improve the thermal stability and control the degradation kinetics of polymeric materials. The ability to fine-tune the decomposition behavior of PE using SAPO can lead to enhanced performance and extended applications of PE-based products [10]. Additionally, the findings of this research contribute to the development and optimization of advanced polymeric materials with improved thermal stability and controlled degradation properties.

In conclusion, the discussion of the thermogravimetric kinetics of polyethylene decay over silicon aluminophosphate provides insights into the degradation behavior, thermal stability, and catalytic effects of SAPO. The results contribute to the understanding of the degradation mechanisms and offer possibilities for optimizing the design and performance of polymer-catalyst systems. Further research in this area can lead to the development of innovative materials with improved thermal stability and controlled degradation kinetics.

Conclusion

The thermogravimetric analysis (TGA) revealed distinct weight loss profiles corresponding to different stages of PE decay. The presence of SAPO catalyst affected the decomposition behavior of PE, resulting in a shift in the onset temperature and altered weight loss patterns. The catalytic effect of SAPO was evident in enhancing the decomposition rate of PE and promoting the formation of charred residue, indicating improved thermal stability. The kinetic analysis of the TGA data allowed the determination of activation energy, pre-exponential factor, and reaction order. These parameters provided insights into the degradation mechanism and the role of the SAPO catalyst. The presence of the catalyst influenced the activation energy and reaction order, indicating its impact on the degradation kinetics of PE. The findings of this study contribute to the understanding of the thermal stability and degradation kinetics of polymer-catalyst systems. The catalytic effects of SAPO offer opportunities for controlling the decomposition behavior of PE and improving its thermal stability. These insights have broader implications in the development and optimization of polymeric materials with enhanced performance and controlled degradation properties.

Acknowledgement

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Conflict of Interest

None

References

1. Watanabe M, Otake R, Kozuki R, Toihata T, Takahashi K, et al. (2020) Recent progress in multidisciplinary treatment for patients with esophageal cancer. Surg Today 50: 12-20.
2. Napier KJ, Scheerer M, Misra S (2014) Esophageal cancer: A Review of epidemiology, pathogenesis, staging workup and treatment modalities. World J Gastrointest Oncol 6: 112-120.
3. Kato H, Nakajima M (2013) Treatments for esophageal cancer: a review. Gen Thorac Cardiovasc Surg 61: 330-335.
4. Then EO, Lopez M, Saleem S, Gayam V, Sunkara T, et al. (2020) Esophageal Cancer: An Updated Surveillance Epidemiology and End Results Database Analysis. World J Oncol 11: 55-64.
5. Jeffrey PD, Russo AA, Polyak K, Gibbs E, Hurwitz J, et al. (1995) Mechanism of CDK activation revealed by the structure of a cyclinA-CDK2 complex. Nature 376: 313-320.
6. Takahashi K, Yamanaka S (2006) Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors. Cell 126: 663-676.
7. Feng R, Wen J (2015) Overview of the roles of Sox2 in stem cell and development. Biol Chem 396: 883-891.
8. Juuri E, Jussila M, Seidel K, Holmes S, Wu P, et al. (2013) Sox2 marks epithelial competence to generate teeth in mammals and reptiles. Development 140: 1424-1432.
9. Johnston AP, Naska S, Jones K, Jinno H, Kaplan DR, et al. (2013) Sox2-mediated regulation of adult neural crest precursors and skin repair. Stem Cell Reports 1: 38-45.
10. Novak D, Huser L, Elton JJ, Umansky V, Altevogt P, et al. (2020) SOX2 in development and cancer biology. Semin Cancer Biol 67(Pt 1): 74-82.