DEGRADATION OF MODIFIED POLYSTYRENES HAVING DEGRADABLE UNITS BY NEAR INFRARED LIGHT IRRADIATION

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Controlled degradation of polymers is getting more and more important to achieve a circular economy. The controlled degradation of polymers is effective against not only the reduction of polymeric waste but also the utilization of composite material products. Based on the degradation of composite material products, there are several reports based on the utilization of gas formation[1,2].

In this study, modified polystyrenes having tertiary ether linkages or carbonate linkages[3,4] were degraded by irradiation of near infrared light (NIR) and subsequent heating. The polymer films containing a photoacid generator[5] and commercially-available photon upconversion nanoparticles (UCNPs)[6] were decomposed to form isobutene and/or carbon dioxide by NIR irradiation and subsequent heating. The thermal decomposition behaviors of the polymers were investigated and discussed in terms of the chemical structures of the degradable units.

Poly(*p-tert*-butoxycarbonyloxystyrene) (PBOCS) and poly(*p-tert*-butoxystyrene) (PTBOS) having tertiary ether linkages or carbonate linkages were degraded by NIR (810 nm) irradiation and subsequent heating. The polymer films containing PAG1 and UCNP were decomposed to form isobutene and/or carbon dioxide by NIR irradiation and subsequent heating. The optimum degradation conditions were as follows: 90-min NIR irradiation and baked at 160 ^{o}C for 5 min (PBOCS), 120-min NIR irradiation and baked at 140 ^{o}C for 5 min (PTBOS). We believe that PTBOS is a promising candidate as a degradable polymer due to its high thermal stability by the NIR degradation and subsequent heating which contributes to easy recycling of composite materials.

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References

1. T. Inui, E. Sato, A. Matsumoto, ACS Appl. Mater. Interfaces, 2012, 4, 2124-2132, 2012.
2. Y. Mori, S. Kishimoto, R. K. Sharma, K. Taki, Ind. Eng. Chem. Res., 62, 15919-15927, 2023.
3. M. Iseki, Y. Hiraoka, C. Jing, H. Okamura, E. Sato, A. Matsumoto, J. Appl. Polym. Sci., 46252, 2008.
4. H. Okamura, E. Yamauchi, M. Shirai, React. Funct. Polym., 71, 480-488, 2011.
5. T. Tsuchimura, J. Photopolym. Sci. Technol., 33, 15-26, 2020.
6. J. Zhou, Q. Liu, W. Feng, Y. Sun, F. Li, Chem. Rev., 115, 395-465, 2015.