

## Stable Polymer formation using polypropylene: Review of Techniques

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### ARTICLE DETAILS

#### Article History

Published Online: 19 December 2019

#### Keywords

MAO metallocene catalyst, temperature.

### ABSTRACT

Metal based catalyst contribute heavily towards the catalytic transformation of organic compounds. Metal oxides, salts and metal complexes exhibit great properties for increasing or decreasing the speed of chemical reactions. This work presents the exhaustive analysis of work done by many researchers towards metallocene catalysts used to form propene polymerization. The mechanisms for formation of propene polymerization corresponding to evolutionary approach of MAO found to best among all. The catalyst formation within the survey is reflected considering different temperature.

### Introduction:

Polymerization is the process of forming polymers by adding catalyst within the polypropylene. The catalyst is used to enhance or slow down the rate with which stable polymers are formed (Zhang et al., 2014). The impact of temperature and pressure on polypropylene polymers are discussed through this literature. POLYPROPYLENE polymers exhibit a complex structure and unique phenomena which cover large areas like monomers, radius of gyration and many times related phenomena which can exist from few seconds to even many years (Arshady, 1992). Many phenomena of POLYPROPYLENE polymerization have been cracked but there are still some fields which require more study. With the advent of technology, simulations can be performed easily even on a device like smartphone (D'Alterio et al., 2020). With all such inventions we can say that simulation of polymers is at fingertips, and it will provide us more detailed study of POLYPROPYLENE polymers.

The iterative approach used within the analysis process includes swarm optimization (Machet et al., 2017). The number of iterations used are 50. The temperature and pressure are varied at each iteration and result is observed (Gao et al., 2018). The peak of rate constants is observed at 40 and 80°C.

Figure 1 gives the structure of polypropylene.

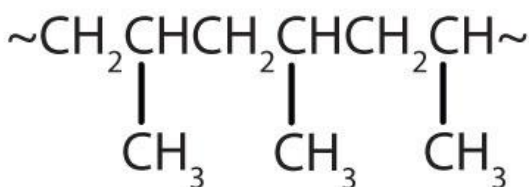


Figure 1: Structure of polypropylene

The iterative approach with increased temperature and pressure will cause the instability in case of reduced temperature and pressure or increased temperature and pressure (Zohuri et al., 2012). The method used for the same is described in next section

### Literature Survey

Method for forming propene polymers through polymerization under different temperatures and pressure ranges is described in this section. The injection molding mechanism is analyzed in detail in this case (Vaughan et al., 2012). The mechanism first uses the simulation of polypropylene based concentration through 50 to 100 mol pressure unit along with starting temperature of 40°C (Childers et al., 2014) and MAO catalyst for increasing or decreasing the rate of reaction for stable polymers formation. The formed polymers were stable, but concentration of polymers causes an issue on increased pressure. As the temperature is increased the polymers formation becomes stable as the formed polymers were smaller in size (Chen et al., 2017). They survive the issue of increased pressure as well.

Polyolefins were among the most common types of marketable synthetic polymers, with an average yearly production of more than 70 billion kg. Propylene polymerization was one of the foremost investigated catalytic organometallic reactions, although since finding of Ziegler-Natta catalysts in the 1950s. Several particular site propylene polymerization catalysts that span the conversion metal sequence have been created over the last three decades, enabling access to hitherto unimagined polymer topologies (Paproth et al., 2005). Metallocene catalysts were first introduced in the 1980s, and they revolutionised our knowledge of how catalyst structure influences polymer microstructure. Brintzinger, Bercaw, and some others discovered a link between both the symmetry of metallocene catalysts and polymer tacticity: isotactic polymers made by C<sub>2</sub>- and C<sub>1</sub>-symmetric complexes (Hess-Dunning et al., 2013), C<sub>s</sub>-symmetric complexes produce syndiotactic polymers, and C<sub>2v</sub>-symmetric complexes produce stereoirregular polymers. Recent developments in post-metallocene olefin polymerization catalysts have resulted in significant improvements in live polymerization and the manufacturing of olefin block copolymers (Goldade et al., 1999).

Through changes of the catalyst ligand structure, homogeneous metallocene polymerization catalysts give novel possibilities to modify the properties and characteristics of poly (R-olefins) (Gulrez et al., 2011). Metallocene catalysts could be used to create a broad range of homo- and copolymer structures. Metallocene catalysts could be used to create

isotactic, syndiotactic, heterotactic, and stereoblock microstructures in polypropylene. Natta would be the one to discover and describe the properties of an elastomeric polypropylene with an atactic-isotactic stereoblock microstructure (Yasuda, 2010). Collette and colleagues discovered that assisted tetralkyl group IVB catalysts may also make elastomeric polypropylene. Chien and colleagues invented the 1<sup>st</sup> metallocene technique for the manufacturing of elastomeric polypropylene in 1990. Chien's catalyst originator had been a stereorigid ansa-titanocene, chiral, with polymer chain development alternating among isospecific and aspecific metallocene coordination places, while various interpretations has been advanced (Schuh et al., 2020).

Here "powder" is the mixture of polypropylene that is fed into the vessel. The screw will be used for increasing or decreasing the pressure. The cylinder will be fitted with the

spindle for increasing or decreasing the temperature (Resconi et al., 2000). The listed mechanism is used most within the formation of propene polymers. Ejector pins and cavity are used for obtaining the result.

The performance analysis under temperature 40 and 80°C is described in next section.

### Performance Analysis

The performance of propylene against temperature and pressure is observed. It was discovered that peaks corresponding to rate constants obtained at temperature range between 40 and 80°C. The catalyst that is used in this case include temperature and pressure. The result corresponding to temperature is presented through figure 2 and figure 3.

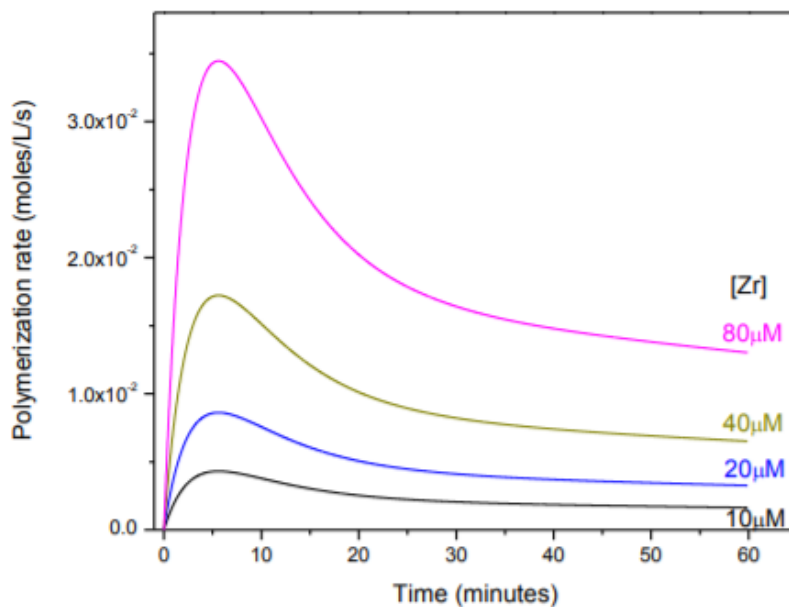


Figure 2: Polypropylene with different temperature and time

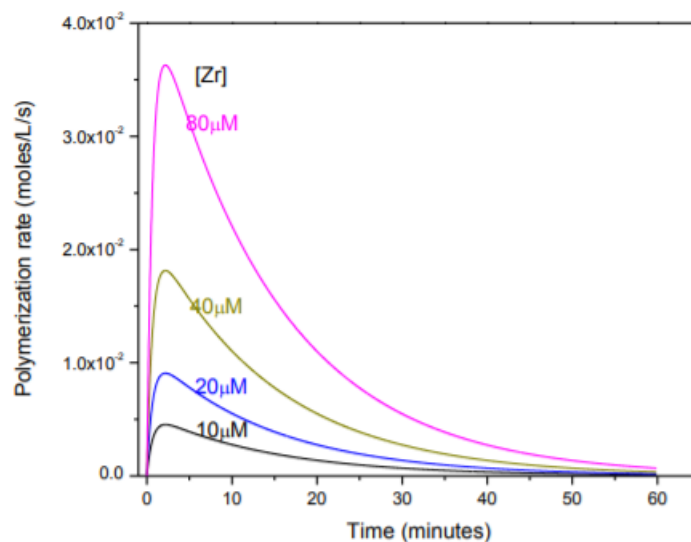


Figure 3: Polypropylene with Zr at different temperature and time

The iterations are performed and with injection modeling it was discovered that at 40 and 80°C stable polymers are formed (Liu et al., 2020).

## Conclusion

This paper presents the exhaustive survey of techniques used in the formation of polymers using the metallocene catalyst. Polymerization with the polypropylene concentration

using injection modeling produced optimal results at 40 and 80°C. The injection method can provide different molecular pressure and increasing or decreasing temperature. The stability of the polymers will be at stake in case temperature is beyond proportion. The polymers stability is surveyed to be the best in between 40 and 80°C.

## References

1. Arshady, R. (1992). Suspension, emulsion, and dispersion polymerization: A methodological survey. *Colloid and Polymer Science* 1992 270:8, 270(8), 717–732. <https://doi.org/10.1007/BF00776142>
2. Chen, Z., Zhao, X., Gong, X., Xu, D., & Ma, Y. (2017). Macrocyclic Trinuclear Nickel Phenoxyimine Catalysts for High-Temperature Polymerization of Ethylene and Isospecific Polymerization of Propylene. *Macromolecules*, 50(17), 6561–6568. <https://doi.org/10.1021/ACS.MACROMOL.7B00996>
3. Childers, M. I., Longo, J. M., van Zee, N. J., Lapointe, A. M., & Coates, G. W. (2014). Stereoselective epoxide polymerization and copolymerization. *Chemical Reviews*, 114(16), 8129–8152. <https://doi.org/10.1021/CR400725X>
4. D'Alterio, M. C., de Rosa, C., & Talarico, G. (2020). Stereoselective Lactide Polymerization: The Challenge of Chiral Catalyst Recognition. *ACS Catalysis*, 10(3), 2221–2225. <https://doi.org/10.1021/ACSCATAL.9B05109>
5. Gao, Y., Chen, X., Zhang, J., Chen, J., Lohr, T. L., & Marks, T. J. (2018). Catalyst Nuclearity Effects on Stereo- and Regioinduction in Pyridylamidohafnium-Catalyzed Propylene and 1-Octene Polymerizations. *Macromolecules*, 51(6), 2401–2410. <https://doi.org/10.1021/ACS.MACROMOL.8B00181>
6. Goldade, V. A., Pinchuk, L. S., & Tsvetkova, E. A. (1999). Polarizing mechanism of colloidal metal particles formation in polymer electrets. *Proceedings - International Symposium on Electrets*, 35–38. <https://doi.org/10.1109/ISE.1999.831815>
7. Gulrez, S. K. H., Al-Assaf, S., & Phillips, G. O. (2011). Hydrogels: Methods of Preparation, Characterisation and Applications. *Progress in Molecular and Environmental Bioengineering - From Analysis and Modeling to Technology Applications*. <https://doi.org/10.5772/24553>
8. Hess-Dunning, A. E., Tyler, D. J., & Zorman, C. A. (2013). Stretchable thin-film metal structures on a stimuli-responsive polymer nanocomposite for mechanically-dynamic microsystems. *2013 Transducers and Eurosensors XXVII: The 17th International Conference on Solid-State Sensors, Actuators and Microsystems, TRANSDUCERS and EUROSENSORS 2013*, 2229–2232. <https://doi.org/10.1109/TRANSDUCERS.2013.6627247>
9. Liu, Z., Yao, C., Wu, C., Zhao, Z., & Cui, D. (2020). Additive-Triggered Chain Transfer to a Solvent in Coordination Polymerization. *Macromolecules*, 53(4), 1205–1211. <https://doi.org/10.1021/ACS.MACROMOL.9B02495>
10. Machat, M. R., Jandl, C., & Rieger, B. (2017). Titanocenes in olefin polymerization: Sustainable catalyst system or an extinct species? *Organometallics*, 36(7), 1408–1418. <https://doi.org/10.1021/ACS.ORGANOMET.7B00112>
11. Paproth, A., Wolter, K. J., & Deltschew, R. (2005). Adhesion of polymer/metal bonds for Molded Interconnect Devices (MID). *28th International Spring Seminar on Electronics Technology: Meeting the Challenges of Electronics Technology Progress, 2005*, 2005, 313–318. <https://doi.org/10.1109/ISSE.2005.1491047>
12. Resconi, L., Cavallo, L., Fait, A., & Piemontesi, F. (2000). Selectivity in Propene Polymerization with Metallocene Catalysts. *Chemical Reviews*, 100(4), 1253–1345. <https://doi.org/10.1021/CR9804691>
13. Schuh, G., Bergweiler, G., Bickendorf, P., Fiedler, F., & Colag, C. (2020). Sheet metal forming using additively manufactured polymer tools. *Procedia CIRP*, 93, 20–25. <https://doi.org/10.1016/J.PROCIR.2020.04.013>
14. Vaughan, A., Davis, D. S., & Hagadorn, J. R. (2012). Industrial Catalysts for Alkene Polymerization. *Polymer Science: A Comprehensive Reference*, 10 Volume Set, 3, 657–672. <https://doi.org/10.1016/B978-0-444-53349-4.00080-7>
15. Yasuda, K. (2010). Self-replicating process for micro interconnect array pattern using solder/polymer hybrid materials. *Proceedings - Electronic Components and Technology Conference*, 1416–1421. <https://doi.org/10.1109/ECTC.2010.5490814>
16. Zhang, Y., Li, J., Li, X., & He, J. (2014). Regio-specific polyacetylenes synthesized from anionic polymerizations of template monomers. *Macromolecules*, 47(18), 6260–6269. <https://doi.org/10.1021/MA501283B>
17. Zohuri, G. H., Albahily, K., Schwerdtfeger, E. D., & Miller, S. A. (2012). Metallocene Alkene Polymerization Catalysts. *Polymer Science: A Comprehensive Reference*, 10 Volume Set, 3, 673–697. <https://doi.org/10.1016/B978-0-444-53349-4.00081-9>