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# CHAIN-GROWTH POLYMERIZATION

TECHNICAL ARTICLES | PROPERTIES OF PLASTICS

Plastic resins used in molding are formed by connecting many short units (monomers) into long, "chain" lengths (polymers). This connecting process is called polymerization. Longer chain lengths give higher molecular weight (Mw) and lower melt flow rates. Polymerization of resin is completed by one of two methods: chain-growth or step-growth. The type of polymerization is dependent on the chemical groups the polymer contains.

This article is an overview of chain-growth polymerization and a list of some of the resins that are formed by it is also included. Next month's article will cover step-growth polymerization.

Chain-growth polymerization forms polymers in a manner similar to adding links to a chain. Chain-growth polymerization starts with a monomer and an initiator. The initiator supplies the chemistry to allow the monomer to polymerize. Chain-growth polymerization is most commonly defined with three types of reactions: initiation, propagation and termination.

Visualize a bucket full of these monomers (links). They are not interconnected and thus move around freely. In order to open a monomer and "link" it to another monomer we must use an "initiator" to start the linking. An initiator (I) is a chemical compound that can create (or contains) a free radical. Free radicals are molecules that contain an unpaired electron<sup>1</sup>.



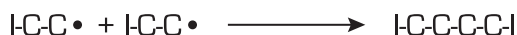
The initiator free radical will react rapidly with the monomer to form a second free radical. (polyethylene monomer is illustrated)



From here, the free radical monomer will react (propagate) with other monomers to form longer and longer free radical polymer chains.



Our bucket now has chains of different lengths. Since the chains are getting longer, it is also getting harder for the links to move around. The chains also start "linking" with each other. This type of scenarios leads to termination.



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Many different resins are polymerized by chain-growth polymerization. All of them must have a carbon-carbon double bond<sup>2</sup>. They include polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS), and polymethylmethacrylate (PMMA) to name just a few.

How long the chains get is the polymer's molecular weight (Mw). The Mw of a material has a direct relationship to physical and mechanical properties. This topic will be a discussion in a later tech article.

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<sup>1</sup> Zeno W. Wicks, Jr., Frank N. Jones, S. Peter Pappas, Organic Coatings: Science and Technology, New York: Wiley, 1999.

<sup>2</sup> Strong, A. Brent, Plastics: Materials and Processing, Prentice Hall, 2000.

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