



Polyethylene can be prepared using a range of different synthetic methods to achieve products with the same chemical repeat unit but vastly different material properties. The differences between these materials are related to the molecular weight of the product and to the amount of branching in the polymer chains. Five grades of polyethylene are commonly defined including:

1. Low Density Polyethylene (LDPE)
2. Linear Low Density Polyethylene (LLDPE)
3. High Density Polyethylene (HDPE)
4. High Molecular Weight High Density Polyethylene
5. Ultrahigh Molecular Weight High Density Polyethylene

LDPE is prepared by radical polymerization and results in a product with short chain branches. This grade usually contains between 15-30 branch points per 500 monomer repeat units. This reduces crystallinity in the material as compared to HDPE resulting in a lower melt point (85-125°C), lower density (.91-.93g/ml), lower tensile strength, and reduced elongation before breaking. LLDPE is a related product in which branched units are intentionally introduced into the polymer structure.

HDPE is made using Ziegler Natta and Phillips catalysts to achieve a more linear polymer structure. This results in a polymer which contains only .5-3 branch points per 500 monomer units. It differs from LDPE not in molecular weight but in the way the molecules are arranged in the polymer chain. HDPE is classically defined as having a number average molecular weight in the range from 50,000-250,000. HDPE melts in the range from 130-140°C and it has a density of .94-.96g/ml. It is also typically 70-90% crystalline as compared to 40-60% for LDPE. The molecular weight is the distinguishing characteristic which separates it from the high and ultrahigh grades of HDPE.

High molecular weight HDPE is defined as HDPE with a molecular weight between 250,000 and 1,500,000. The higher molecular weight of this polymer imparts higher tensile strength, elongation, stress cracking resistance, and low temperature impact resistance. It is also more difficult to process due to its very high melt viscosity. Ultrahigh molecular weight HDPE is defined as HDPE with a molecular weight of 1,500,000 or greater. This grade is produced primarily for its high abrasion resistance and impact strength which are greater than for any other thermoplastic.



#### Works Cited

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