Fabrication of Ultra-High Molecular Weight Polyethylene by MgO-Supported Ziegler-Natta Catalyst

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[Introduction]

Ultra-high molecular weight polyethylene (UHMWPE) is excellent in impact strength, sliding property and abrasion resistance, and it is used for artificial hip joints and machine parts. In molding process of UHMWPE which is inferior in fluidity at the time of melting, a special method using polymer powder is required, and defects due to particle interface are a problem. Also, the produced UHMWPE particles are hard and difficult to crush further finely by grinding. Therefore, UHMWPE with small particle size can only be obtained by controlling the particle size during polymerization. In the case of heterogeneous catalysts, it is known that the morphology of the polymer depends on the catalyst particles, and the size of the polymer is proportional to the catalyst particle size and polymerization activity used. Reducing the particle size of the polymer and narrowing the particle size distribution is one of the methods to solve problems such as defective joining of grain boundaries when performing compression molding. However, at present, there are many processes for preparing the Ziegler-Natta catalyst, and advanced techniques are necessary because the catalyst form changes due to multivariate factors. Catalyst preparation using magnesium oxide (MgO) nanoparticles can be easily prepared only by chlorinating the surface of MgO particles, and the particle morphology does not change before and after treatment. In addition, MgO nanoparticles are prepared by a build-up method, and can obtain a nanometer size particle with narrow particle size distribution. Therefore, it is possible to obtain a catalyst having a small particle size and a narrow particle size distribution without going through complicated steps such as conventional Ziegler-Natta catalyst preparation. Hence, the MgO-supported Ziegler-Natta catalyst can be a very excellent catalyst which can easily obtain UHMWPE particles having a small particle size and narrow particle size distribution.

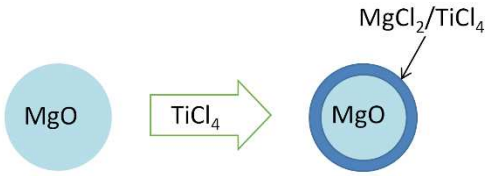

Figure 1 Method of catalyst preparation.

[Results and discussion]

This study was able to control the catalyst particle diameter by the support particle size by using MgO nanoparticles as a carrier and synthesized primary particles of nm size directly. Since the catalyst can be easily obtained only by treating MgO nanoparticles with $TiCl_4$, the catalyst preparation process is largely simplified. Also, since only the outermost surface of the MgO particles is catalyzed, the Cl component can be remarkably reduced as compared with the conventional catalyst. The particle diameter of the UHMWPE particles synthesized by the catalyst primary particles is several μm, which is far smaller than the industrially synthesized degree of 70-200 μm. Hence, reduction of molding temperature accompanying decrease of fusion temperature of particles and improvement of physical properties by reduction of gaps between particles could be achieved. On the other hand, by adjusting agglomeration of primary particles as a structural unit by a spray dry method, a bottom-up design that controls the morphology of secondary particles was made possible. The synthesized UHMWPE particles had the same molding processability as polymer particles of several μm. Hence, the findings obtained in this study will contribute to the expanded use of UHMWPE.

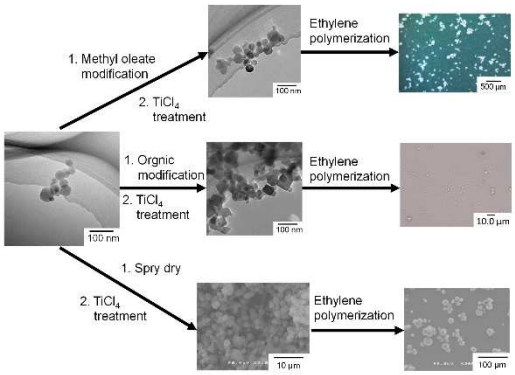

Figure 2 The synthesized UHMWPE particles.

Key word: Ultra-high molecular weight polyethylene, Ziegler-Natta catalyst, core-shell catalyst, magnesium oxide,