**Study on mechanical properties under bending deformation of bar-shaped crystalline plastic materials**

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Plastic products are indispensable in our modern life. Especially in the fields of home appliances and daily necessities, a wide variety of products using crystalline plastic materials are on the market. These are used for a certain period of time in a situation close to the human body. Therefore, safety is strongly required. In particular, fracture under bending deformation must be avoided. However, most crystalline plastic materials show a brittle fracture when a bending load is applied. Hence, the improvement of mechanical properties is demanded for the industrial application.

In this study, the purpose is to establish a novel design method that realizes fracture suppression under bending deformation from the viewpoint of "structural control of injection-molded parts" mainly using polypropylene and polyoxymethylene as typical crystalline plastic materials. The thesis is composed of the following chapters.

**Chapter 1 General introduction**

**Chapter 2 Improvement of fracture toughness of crystalline plastic materials using laminated structure**

The effect of elastomer lamination on the failure mode of bar-shaped injection molded specimens using isotactic polypropylene was demonstrated during bending deformation. When a thermoplastic elastomer sheet was laminated on polypropylene, the specimen showed high mechanical toughness without stress whitening. Although rubbery materials have low tensile moduli, their bulk moduli are comparable to those of plastics. Therefore, the laminated elastomer, located inside of the bending deformation, prohibits sharp bending angles, leading to stress concentration, during the deformation. As a result, craze formation, which is the origin of stress whitening and leads to brittle fracture, hardly occurs. Since this elastomer lamination method can prevent a molded product from being destroyed when an excessive external force is applied, it can be employed more for various applications in bar-shaped goods that require safety.

**Chapter 3 Audible sound generation of crystalline plastic material using hinge structure**

Audible sound generation due to snap-through buckling during bending deformation was studied using an injection-molded specimen with a hinge mainly using polyoxymethylene. The sound was clearly generated in rigid plastic materials with a specific shape of the hinge that was markedly deformed. The large elastic energy stored in the hinge by the bending deformation, which was suddenly released during buckling deformation, was responsible for the increased sound pressure levels. This phenomenon investigated in this study will be useful in the design of bar-shaped intelligent plastic products that alert users to stress levels, thereby ensuring their safety. Furthermore, the rapid decrease in the stress is also effective to avoid brittle fracture leading to sharp edges of broken pieces.

**Chapter 4 General conclusion**

**Key words**

Polypropylene, polyoxymethylene, Mechanical properties, bending deformation, Structural control