Biodegradability of Urethane

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Several biodegradable polyurethanes have been developed. However, the biodegradation has only been discussed in terms of molecular weight, weight loss, and mechanical deterioration. These phenomena do not show the biodegradation of urethane bonds in a polymer backbone directly because the common polyurethanes contained other segments, such as polyester, polyether, or saccharide units. On the other hand, if urethane compounds can be shown to maintain mechanical properties, they could lead to the development of a biodegradable elastomer. We have, therefore, been studying the biodegradability of urethane compounds, including model compounds and polymers. In this paper, we describe the biodegradation of oligomers and polymers which contain only urethane as a possible biodegradable bond.

Various urethane oligomers and polymers were synthesized by the reaction of low molecular weight diols such as ethylene glycol, diethylene glycol, 1,4-butanediol, and polycaprolactone diols with diisocyanates, such as hexamethylene diisocyanate (HDI), lysine diisocyanate (LDI), etc. These compounds contain only urethane as a possible biodegradable bond.

Biodegradability was evaluated by an activated sludge test and enzymatic hydrolysis using esterases and proteases. The biodegradation of the polymer by activated sludge was rather slow compared to that of the oligomer. The oligomers based on HDI and LDI showed higher degradation than those based on MDI. In the case of enzymatic hydrolysis, the LDI-based polyurethanes degraded more readily compared with HDI- and MDI-based polyurethanes and show potential as biodegradable elastomer, plasticizer and compatibilizer for biodegradable plastics. Urethane degrading-microorganisms were also isolated from the activated sludge.