



Université  
du Maine

**Preparation of Polyurethane Foams from Hydroxytelechelic Oligoisoprenes  
Obtained by Controlled Degradation of Natural Rubber: Study of  
Their Physico-mechanical, Thermal, and Acoustic Properties**

**Anuwat Saetung**

**A Thesis Submitted in Fulfillment of the Requirements for  
the Degree of Doctor of Philosophy  
(Polymer Technology)  
Graduate School  
Prince of Songkla University  
Pattani, Thailand**

**and**

**Le Grade de Docteur de l'Université du Maine  
(Spécialité: Chimie et Physicochimie des Polymères)  
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**Major Program** Polymer Technology

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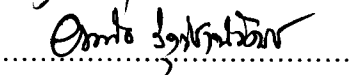
  
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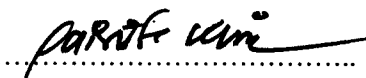
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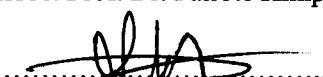
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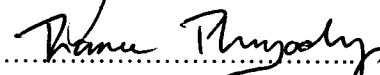
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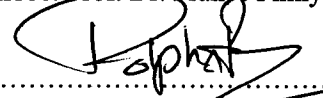
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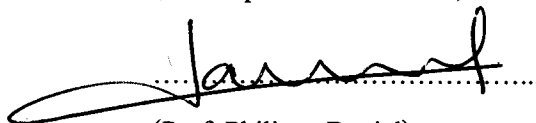
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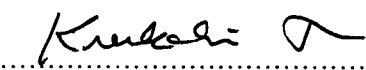
  
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The Graduate School, Prince of Songkla University, Thailand and Faculté des Sciences et  
Techniques, Université du Maine, Le Mans, France, have approved this thesis as fulfillment of the  
requirements for the Degree of Doctor of Philosophy (Polymer Technology) and the Grade of  
Docteur de l'Université du Maine (Chimie et Physicochimie des Polymères).

  
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<b>Author</b>	Mr. Anuwat Saetung
<b>Major Program</b>	Polymer Technology
<b>Academic Year</b>	2008

### ABSTRACT

Polyurethane foam (PUF) is the largest of polyurethane materials widely studied and used in many applications such as furniture, automobile, insulation, acoustic absorber. Hydroxyl compounds currently used in the production of PUF are petrochemical products (polyester and polyether polyols). However, they have some disadvantages as they are non-renewable resources, they may cause environmental pollution, and they tend to be exhausted in the near future. Natural rubber (NR) is an interesting choice to use as a starting material in PUF synthesis, due to the fact that they are renewable source, abundant polymer and they have good mechanical properties and are easy to chemically modify.

In this work, a new hydroxytelechelic natural rubber (HTNR) having a hydroxyl functionality of 2 was successfully performed *via* controlled epoxidation and cleavage of natural rubber, following by a selective reduction reaction of the obtained carbonyltelechelic oligoisoprenes. These HTNR with different molecular weights (1000-3400 g mol<sup>-1</sup>) were reproducibly obtained with high yields. Chemical modifications on HTNR were performed by epoxidation (10-35%, EHTNR), hydrogenation and oxirane opening reactions. The different microstructures of these oligomers were evidenced by the characterization techniques FT-IR, NMR, SEC and MALDI-TOF MS. Their thermal properties were also investigated by TGA and DSC.

Polyurethane foams were successfully prepared from a renewable source, HTNR with different molecular weights and EHTNR having a variation of epoxide content, by one shot technique. The chemical structure and cell structure as well as physico-mechanical, thermal and acoustic properties were characterized to compare with commercial polyol analogues. It was investigated that the obtained HTNR based foams are open cell structures and have cell

dimensions between 0.38 and 0.47 mm. Concerning, physico-mechanical properties, HTNR1000 based foam exhibits higher tensile and compressive strengths than commercial polyol analogue, but the elongation at break is lower. However, HTNR3400 based foam shows the best for elastic properties. In series of EHTNR based foams, the tensile and compressive strengths give a trendy increasing with increasing the epoxide content. Same results were observed with increasing amount of 1,4-butanediol. For thermal properties, HTNR based foams show better low temperature flexibility than that based on commercial polyol. Moreover, HTNR based polyurethane foams give an excellent acoustic absorber.

**Keyword:** Natural rubber, Polyurethane foam, Telechelic oligomer, Degradation, Mechanical properties, Thermal properties, Acoustic absorption properties.