

Guayule Latex; Physical, Chemical, and Rheological Properties

Colleen M. McMahan¹, Jali Williams², Katrina Cornish²

¹USDA-ARS, Western Regional Research Center, Albany, CA 94710, USA

²Yulex Corporation, Maricopa, AZ 85239, USA

Abstract

Natural rubber is the largest single volume elastomer in commerce, at ~9 million tons sold globally per year. It is a strategic raw material used in thousands of applications: critically in medical devices, personal protective equipment, and specialty industrial applications such as aircraft tires. Over 2500 plant species produce natural rubber; alternatives to *Hevea brasiliensis* have the potential to provide economic, social, and strategic benefits to the USA. Guayule latex has recently entered the commercial arena as an alternative natural rubber latex suitable for the manufacture of latex medical products safe for people with Type I IgE-mediated *Hevea* latex allergies. Produced from *Parthenium argentatum*, a desert shrub indigenous to North America, re-introduction of guayule provides opportunities for rural development as a significant industrial crop. Here we examine the physical, chemical, and rheological properties of guayule latex and rubber produced in the United States.

Introduction

Natural rubber, nature's original biopolymer, today remains the largest single volume elastomer in commerce. A polymer of chemical structure cis-1,4-polyisoprene, it is produced by biosynthesis in plants in the form of latex. The insoluble rubber is encapsulated in ~1µm diameter latex particles with lipid monolayer membranes consisting of species-specific fatty acids, proteins, and lipids. Produced almost exclusively in tropical countries by *Hevea brasiliensis*, the Brazilian rubber tree, its performance in critical applications such as aircraft tires and medical devices has not been duplicated by synthetics. Prices have increased over 80% since 2005 and supplies continue to tighten. The demand for natural rubber latex is predicted to exceed 2 million tons by 2020, about double current consumption. In 2005, the International Rubber Study Group predicted a 2-3 million ton per year shortfall in the global rubber supply by 2020.

Parthenium argentatum, guayule, is a desert shrub native to the southwestern United States that produces high quality natural rubber by biosynthesis. Recent commercial success in producing natural rubber latex from guayule has resulted in its re-introduction as a new crop in the USA. Guayule natural rubber latex (GNRL) is now produced on a commercial scale as latex for high-value medical and consumer products markets, as a safe renewable alternative to synthetic latex products for people with Type I IgE-mediated *Hevea* latex allergies. A 'green' aqueous-based latex extraction process currently consumes over ~45,000 pounds fresh shrub per day in the southwestern United States in the manufacture of ~800,000 lbs/year commercial guayule latex.

Guayule rubber has a long history of agronomic and commercial development. However, due to high interest in tire applications, the available literature describing the properties and performance of guayule latex is limited. The objective of this report is to summarize the physical, chemical, and rheological properties of modern guayule latex, a new biopolymer produced in the United States of America.

Results

Results from process development and commercial latex samples, tested in two different laboratories, meet the ASTM specification for total protein, less than 200 µg protein per g rubber (Table 2).

In addition, specification of Category 4 latex also requires that the latex contain no protein that can be detected by ASTM D6499-03 Standard Test Method for Immunological Measurement of Antigenic Protein in Natural Rubber and its Products. The test is commonly referred to as the Latex ELISA for Antigenic Protein (LEAP). This immunoassay procedure quantitatively measured the level of antigenic latex proteins in a solution using an inhibition format. In an inhibition ELISA, soluble antigens in the extract compete for binding to specific anti-latex antibodies and block antibody binding to latex antigen immobilized on the surface of the assay plate. The rabbit polyclonal antibody used was raised against protein extracted from *Hevea* NRL glove films. A lack of cross-reactivity in D6499 ensures both the intrinsic safety of Category 4 latex and that the latex has not become contaminated with *Hevea* latex as has occasionally happened, for example, with nitrile latex.

The combination of undetectable antigenic protein and low total protein provides the extra safety feature of very low protein exposure during product use, which will greatly reduce the chances of a user becoming allergic to a Category 4 latex or latex product. It is clear that if high levels of protein are not present in the raw material they cannot appear in the manufactured product.

Conclusions

Results presented here illustrate key elements of the state of the technology of modern guayule natural rubber latex, throughout development and commercialization. The material meets ASTM Category 4 latex requirements. Commercial specifications reflect the ASTM requirements as well as application needs, and as such as evolving. Process consistency continues to improve, as evidenced in material properties, especially latex particle size.