# Reclaiming of Natural Rubber Latex Product Waste by a Mechanochemical Process for Production of Solid Tire Treads

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**Reclaiming of Natural Rubber Latex Product Waste by a Mechanochemical Process for Production of Solid Tire Treads**

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## Declaration

**"The work described in this research was carried out by me under the supervision of Dr. Dilhara G. Edirisinghe and a report on this has not been submitted in whole or in part to any university or any other institution for another Degree/Diploma"**

**.....**

**Signature of the Student**

**.....**

**Date (30.04.2015)**

**"I certify that the above statement made by the candidate is true and that this project is suitable for submission to the university for the purpose of evaluation"**

.....

**Signature of the Supervisor**

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30.04.2015

**Date**

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# ABSTRACT

Use of reclaimed rubber in rubber compounds is a common practice to improve processability and reduce cost. The main aim of this research was to develop a novel mechanochemical reclaiming process for natural rubber latex product waste. Mechanochemical reclaiming was performed at low temperature with IPPD, an amine type antioxidant. Thereafter, virgin natural rubber (NR) was blended with the novel reclaimed rubber according to a solid tyre tread formulation. A series of virgin NR / novel reclaimed rubber composites was prepared by replacement of virgin NR with novel reclaimed rubber at 10 phr intervals; the maximum loading of the reclaimed rubber was 50 phr. Reclaimed rubber was characterised and Mooney viscosity, glass-transition temperature (Tg), cure characteristics, physico-mechanical properties and aging performance of the composites were evaluated.

Above characterisation techniques indicated that 2 phr and 5 min. wad the optimum loading and milling time, respectively for reclaiming with IPPD. Minimum and maximum torques increased with the increase of novel reclaimed rubber content, whereas scorch and cure times showed a decreasing trend with rheometer results. However, the lowest Mooney viscosity and Tg was obtained by the composite with the highest reclaimed rubber loading. There was no significant decrease in tensile strength up to 40 phr loading. Moduli, elongation at break and resilience did not vary significantly with the increase of reclaimed rubber content from 10 to 40 phr. Hardness, tear strength and abrasion volume loss of the composites prepared with 10 to 30 phr loading of reclaimed rubber were at the acceptable level for tyre treads. As the reclaiming agent was an antioxidant, the aging performance of the composites

containing reclaimed rubber was superior to that of the 100% virgin NR composite. Results in overall indicated that the 70:30 virgin NR / novel reclaimed rubber composite would be suitable to manufacture solid tyre treads.

# CHAPTER 1: INTRODUCTION

## 1.0 Introduction

Sri Lanka has the potential to be one of the world leading rubber product manufacturing countries due to its production of high quality raw materials, top quality grade of natural rubber (NR) with a very low level of proteins, high quality production of RSS and relatively low processing cost. A wide variety of rubber products is currently manufactured by the rubber manufacturing sector in Sri Lanka. Surgical, household, agricultural and examination gloves, balloons, hallowing masks and rubber toys are among the major products manufactured by the latex industries in Sri Lanka.

The Rubber industry in Sri Lanka has expanded significantly over the last decade and presently it produced around 152MT annually ( Table 1.1). Centrifuge latex production has gone up in Year 2012 by 40%.

**Table 1.1 Rubber production in Sri Lanka by different types (MT )**

| Year | Sheet | Sole Crepe | Latex crepe | Scrap crepe | TSR | Centrifuged latex and other | Total |
|---|---|---|---|---|---|---|---|
| 2000 | 34,003 | 4512 | 28110 | 1788 | 3879 | 15344 | 87636 |
| 2001 | 30,344 | 3915 | 26112 | 2743 | 3657 | 19461 | 86236 |
| 2002 | 42,770 | 2987 | 20831 | 2185 | 1231 | 20514 | 90519 |
| 2003 | 50,015 | 2195 | 17131 | 3117 | 1193 | 18359 | 92010 |
| 2004 | 46,705 | 2035 | 12481 | 3708 | 2812 | 27000 | 94741 |
| 2005 | 50,170 | 2739 | 12914 | 2883 | 5880 | 29766 | 104352 |
| 2006 | 46,260 | 3949 | 20224 | 1606 | 9038 | 28076 | 109153 |
| 2007 | 48,875 | 4077 | 21756 | 1693 | 9564 | 31586 | 117551 |
| 2008 | 55,011 | 3937 | 21043 | 2711 | 10968 | 35573 | 129243 |
| 2009 | 54,550 | 5448 | 31670 | 3502 | 11775 | 29934 | 136880 |
| 2010 | 59,248 | 6711 | 52504 | 1842 | 8341 | 24341 | 152987 |
| 2011 | 60,699 | 3384 | 59933 | 1332 | 7981 | 24869 | 158198 |
| 2012 | 59,242 | 1,902 | 36,550 | 1,280 | 8,672 | 44,403 | 152,050 |
| 2013 | 62,800 | 2,379 | 15,373 | 2, 440 | 9,566 | 37,863 | 130,421 |

Source: Rubber Development Department

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Sri Lanka has many leading rubber product manufacturers in the country whose products are very competitive in global markets. Some of them are Ansell Lanka (Pvt.), DSI Group, Camoplastsolideal (Pvt.) Ltd., Lalan Group, Dipped Products Ltd, Trelleborg (Pvt.) Ltd, Associated Motorways Ltd., Richard Peiris Group, etc.

In terms of export value, the rubber products industry (solid tyres, pneumatic tyres and tubes, plates, sheets and strips, surgical gloves and other gloves, floor coverings and mats, etc.) recorded a high growth from US $ 539.91 million in the year 2008 to US $ 889.40 million in the year 2014 (Table 1.2)

Sri Lanka can boast of international accepted products such as solideal branded industrial tyres manufactured here by Loadstar Ltd. Loadstar enjoys more than 20% of the international market. Trelleborg Lanka Ltd. also produces solid tyres to the global market. Sri Lanka in Southeast Asia which enjoys a large rubber output, developed rapidly in solid tyre manufacturing field in recent years by virtue of their advantages in resources.

USA is the largest importer of solid tyres from Sri Lanka. Belgium, Germany, Italy are the other major importers of solid tyre products. Solid industrial tyres are primarily used in material handling vehicles in areas such as airports, ports and transporting goods for storage. Sri Lanka has developed into a center for the production of solid industrial tyres. Sri Lankan solid tyre sector earned US $ million 352 in year 2011 and US $ million 331 in year 2012. However the quantity of solid tyre exports had come down by 15% in year 2012.

**Table 1.2 Exports of Rubber Products Value in US$ Mn**

| Product | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| Pneumatic & Retreated Rubber Tyres & Tubes | 337.97 | 214.27 | 337.78 | 571.4 | 541.22 | 554.6 | 567.59 |
| Industrial & Surgical Gloves of Rubber | 117.22 | 113.87 | 136.92 | 180.98 | 176.34 | 195.4 | 175.93 |
| Gaskets, Washers, Seals etc. of Hard Rubber | 71.89 | 41.47 | 62.84 | 89.53 | 76.71 | 79.87 | 95.56 |
| Rubber Plates, Sheets Rods of Vulcanized or Unhardened Rubber | 10.14 | 12.21 | 17.21 | 39.25 | 59.65 | 54.83 | 47.76 |
| Other Rubber Products | 2.69 | 2.5 | 2.06 | 2.99 | 2.76 | 2.72 | 2.57 |
| Total | **539.91** | **384.32** | **556.81** | **884.15** | **856.68** | **887.42** | **889.4** |

(Source: Sri Lanka Customs )