

# NEW VALUE CREATION

J.B. Dunlop invented the world's first inflated tire more than a century ago. Carrying on the torch of Dunlop's pioneering spirit, the SRI Group has endeavored to promote new value creation for tires through innovative ideas and technologies. Tracking the evolution of tire technology, people have continued to enjoy the benefits of an advanced motorized society today. Despite these benefits, motorization has also contributed to a number of issues that cannot be ignored, including global warming: CO<sub>2</sub> emissions from automobiles and the burning of fossil fuels during both manufacturing and driving are imposing burdens on the environment. Against this backdrop, the SRI Group added "social responsibility" to its guidelines that have focused on "safety" and "comfort" as indices of *monozukuri* (manufacturing). We are pleased to introduce our new and unique tires along with technology that resulted from our endeavors to "Create New Value."

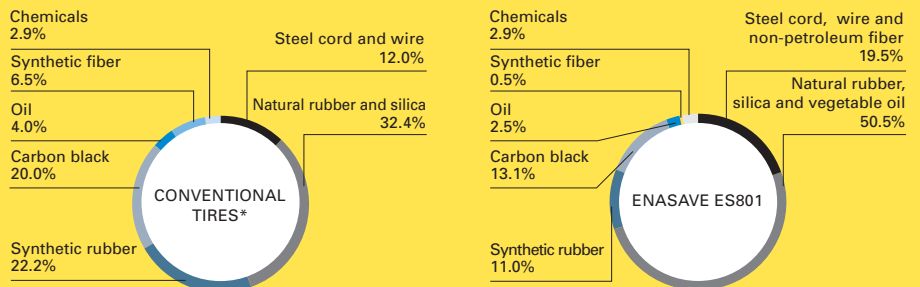
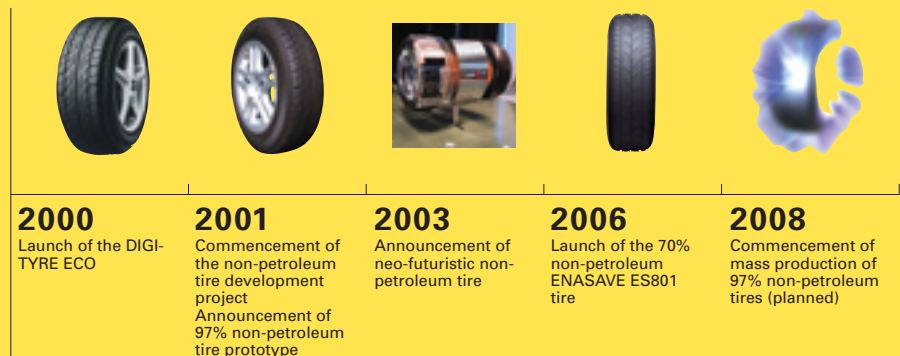
# 1. NON-PETROLEUM TIRES



ENASAVE ES801

## APPROACH TO ECO-TIRE DEVELOPMENT

In its focus on actions a tire manufacturer can take to reduce burdens on the environment, the SRI Group has worked diligently on the development of an environmentally friendly "eco-tire." In 2000, the Group launched the Dunlop DIGI-TYRE ECO that combines fuel efficiency and durability as well as basic driving performance. Furthermore, the Group embarked on a development project for non-petroleum tires to lower oil dependence and exhibited a prototype with 97% of its tire-weight made from non-petroleum resources at the Tokyo Motor Show in 2001. At the same Show in 2003, we announced a neo-futuristic non-petroleum tire embedded with sensors, which generated a great deal of interest and feedback. Finally, in October 2005 the SRI Group announced details of the ENASAVE ES801 tire that realizes a 70% proportion of non-petroleum materials. The ENASAVE ES801 tire was released to the market in March 2006.



Non-petroleum material ratio **44%**      ▶      Non-petroleum material ratio **70%**

**TIRE COMPOSITION RATIO BY WEIGHT 195/65R15 (9KG)**

\* Composition ratio of the average weight of materials for a passenger car tire manufactured at SRI Group's factories (195/65R15 of approximately 9.0kg)

**70% NON-PETROLEUM-MADE TIRE: ENASAVE ES801**

Tires are made from over 100 kinds of materials. Of this number, the four main petroleum materials are synthetic rubber, carbon black for filler, oil and synthetic fiber for casing. The Dunlop ENASAVE ES801 tire reduces the use of synthetic rubber by increasing natural rubber and utilizes natural materials for filler, oil and casing. This has successfully raised the proportion of non-petroleum materials from 44% for our conventional tires to 70% for the ENASAVE ES801. The increased use of natural rubber has also lowered rolling resistance by 30%, contributing to improved fuel consumption.

**EPOXIDIZED NATURAL RUBBER COMPOUNDING**

Tires that have high natural rubber content exhibit poor traction during braking and cornering. In order to overcome this problem, the SRI Group utilizes natural rubber that has a modified molecular structure. The mol-

ecular structure of epoxidized natural rubber is similar to that of synthetic rubber. Synthetic rubber has benzene rings protruding like branches from rubber molecules while epoxidized natural rubber has epoxide group on the rubber molecules instead. The epoxide group reduces molecular vibration caused by the rubber touching the road surface, improving overall traction. Utilizing epoxidized natural rubber has enabled us to lower the proportion of synthetic rubber, which previously had a major role in the traction of conventional tires.

**UTILIZING DIGI-COMPOUND SIMULATION TECHNOLOGY**



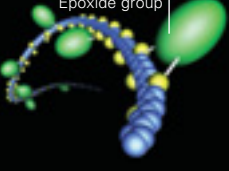
Digi-Compound, a material simulation technology at the nanometer level, played an important role in the development of epoxidized natural rubber. Digi-Compound enables us to see molecular-level changes in materials such as filler and casing of rolling tires, allowing for optimal rubber compound examination. With the full utilization of this technology, it became possi-

ble to develop new materials that combine the high fuel efficiency provided by natural rubber with driving performance.

In addition, our digital rolling simulation technology, DRS II, which predicts tire movement and deformation for moving vehicles using computer simulation, contributes to tire development for assuring driving performance to support cutting-edge hybrid cars.

**AIMING FOR PRACTICAL APPLICATION OF 97% NON-PETROLEUM TIRES**

The SRI Group strives for the development of tires with 97% of their weight made from non-petroleum materials, and a market launch in 2008. The world's first inflated tire created by J.B. Dunlop in 1888 was made from 100% natural rubber. By returning to natural resources with a "new retro tire," the Group will create value with an eye on the future.

SYNTHETIC RUBBER	NATURAL RUBBER	EPOXIDIZED NATURAL RUBBER
		
<p>Benzene rings attached to rubber molecules transform the overall molecular structure for better traction</p>	<p>Weak vibration in rubber molecules results in poor traction</p>	<p>Epoxide group transforms the molecular structure of rubber for better traction</p>
<p>THE MOLECULAR STRUCTURE OF RUBBER (IMAGE)</p>		

## 2. NOISE REDUCTION TIRES



LE MANS LM703

### INCREASING DEMAND FOR LOW PROFILE TIRES

Low profile tires have a relatively wider tread and narrower sidewalls. Aside from their attractive appearance, the advantages of using low profile tires are their stable performance during high-speed driving and cornering. For these reasons, demand for low profile tires is recently increasing. Nevertheless, there are challenges with respect to quietness and ride/comfort, so the SRI Group has made a number of studies to realize more comfortable-driving low profile tires. Through these studies, the Group developed and marketed the LE MANS LM703 tire.

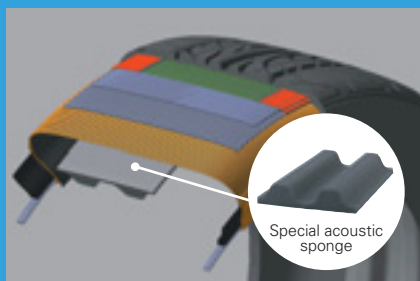
### LE MANS LM703: WORLD'S FIRST ACOUSTIC SPONGE-MOUNTED TIRE

The air inside a tire vibrates in accordance with road contour. The Dunlop LE MANS LM703 tire reduces air vibration with a uniquely shaped sponge made from special

materials. This tire is successful in significantly reducing cavernous resonance, a problem previously difficult to solve. Cavernous resonance is the sound made by the air inside tires, which is often heard when driving across joints on an expressway. The SRI Group believes that the LE MANS LM703 is the world's first passenger car tire that reduces noise by a special sponge mounted inside the tire. The Group has acquired several patents for this technology in Japan and the United States, and is now applying for a total of 68 patents in Japan and around the world.

### ADVANCED SIMULATION TECHNOLOGY: DRS III

Cavernous resonance, the air vibration inside tires, is transferred from the wheel to the suspension, ending up as noise inside the car. This process was discovered by the Group's DRS III technology, which simulates air pressure fluctuation inside the

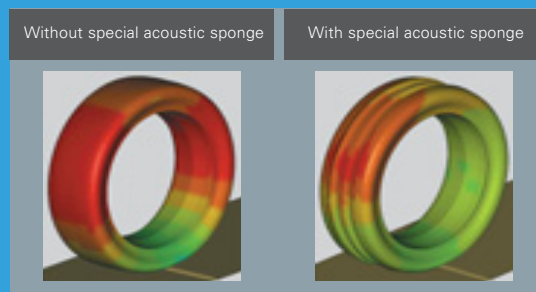


Inhibits noise caused by pressure fluctuation inside tire

SPECIAL ACOUSTIC SPONGE MOUNTED



Compares the pressure fluctuation inside tire when driving across joints on an expressway



VERIFICATION BY PRESSURE FLUCTUATION SIMULATION

### 3. RUNFLAT/SPARELESS TECHNOLOGIES

tire. When focusing on one spot of the tire, details of pressure fluctuations and air vibrations can be analyzed in simulations. By these means, we were able to develop the special acoustic sponge that effectively curbs air vibration for the LE MANS LM703, a successful case in decreasing cavernous resonance through simulation technology.

#### REDUCTION OF ROAD NOISE

When driving on rugged roads, the vibrations of the breaker edge of the tires are transferred to the sidewalls, wheels and suspension, causing noise inside the car. Our proprietary simulation technology discovered that road noise is caused in this process. The LE MANS LM703 tire adopts a new combination band structure using a PEN band, which is approximately four times stronger than a conventional nylon band. This new combination band decreases vibrations on the breaker edge, contributing to noise reduction inside the vehicle.

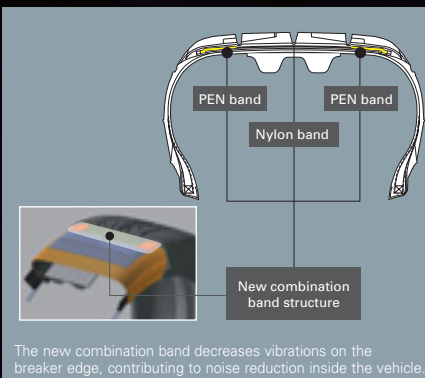
Runflat tires allow for safe driving, as they are able to run for a certain distance even when flat. They eliminate the need for spare tires and realize fuel efficiency through reduced vehicle weight. The SRI Group offers four types of runflat/spareless technologies to accommodate various car models.

The DSST CTT Runflat tire has reinforced sidewalls, an improved ride/comfort and trimmed weight in a unique shape. It is used in luxury vehicles such as Toyota's Lexus SC430 North American models. The DSST Runflat is a conventional tire with reinforced sidewalls, fitted on over 70% of BMW Group cars under both the Dunlop and Goodyear brand names.

The PAX System consists of a tire, a special wheel, a support ring to support tires in the event of a puncture, and a tire deflation warning system (DWS). Based upon a licensing agreement with

Michelin, the SRI Group develops and promotes the PAX system under the Dunlop brand name.

The Group's DWS technology warns of decreases in air pressure due to punctures by detecting changes in tire revolutions through ABS. In addition, IMS is an emergency system that fills punctured tires with sealant. Both DWS and IMS are utilized in a growing number of automobiles and are enjoying steady increases in sales.



The new combination band decreases vibrations on the breaker edge, contributing to noise reduction inside the vehicle.