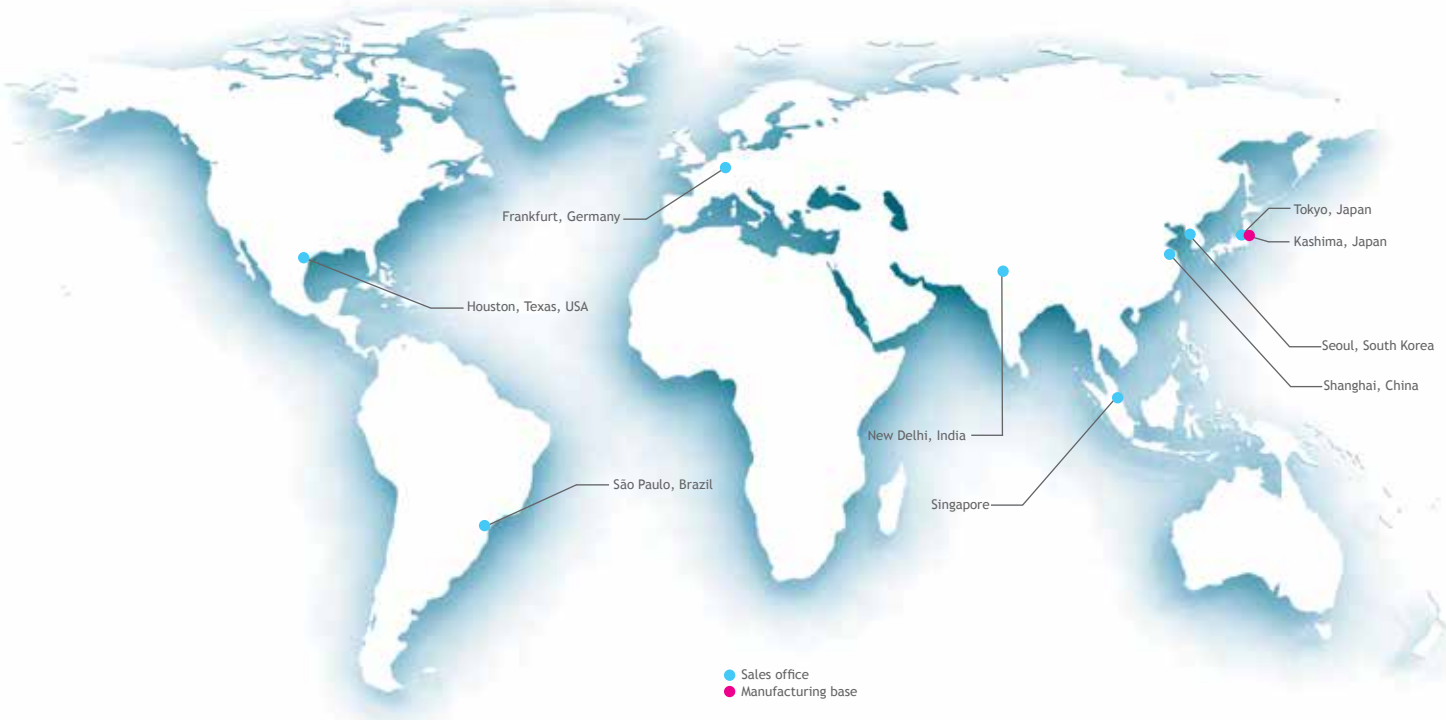


Adding value to your products - worldwide



Kuraray is a world leader in specialty chemicals and functional materials. We are committed to developing products that ensure quality and value while helping our customers differentiate themselves from their competition.

The history of Kuraray's Elastomer Division started in 1972 with the production of polyisoprene rubber and the development of new rubber materials based on Isoprene in the Kashima Plant. From the

first production line, the Elastomer Division continuously grew and invented new products such as KURARAY LIQUID RUBBER, ISOBAM™, SEPTON™, HYBRAR™, and KURARITY™.

Kuraray strives to develop new and innovative high performance products for customers around the globe. If you would like to know more about Kuraray's Elastomer products please also visit our website [www.elastomer.kuraray.com](http://www.elastomer.kuraray.com)

#### Kuraray Co., Ltd.

Ote Center Bldg.  
1-1-3, Otemachi Chiyoda-ku  
Tokyo 100-8115, Japan  
Phone: +81 3 6701 1616  
[kuraray.liquidrubber@kuraray.com](mailto:kuraray.liquidrubber@kuraray.com)

#### Kuraray Europe GmbH

Philipp-Reis-Straße 4  
65795 Hattersheim am Main  
Germany  
Phone: +49 69 305 35849  
[elastomer@kuraray.com](mailto:elastomer@kuraray.com)

#### Kuraray America, Inc.

2625 Bay Area Blvd.,  
Suite 600, Houston TX 77058  
United States of America  
Phone: +1-281 283 1711  
[septon.sales@kuraray.com](mailto:septon.sales@kuraray.com)

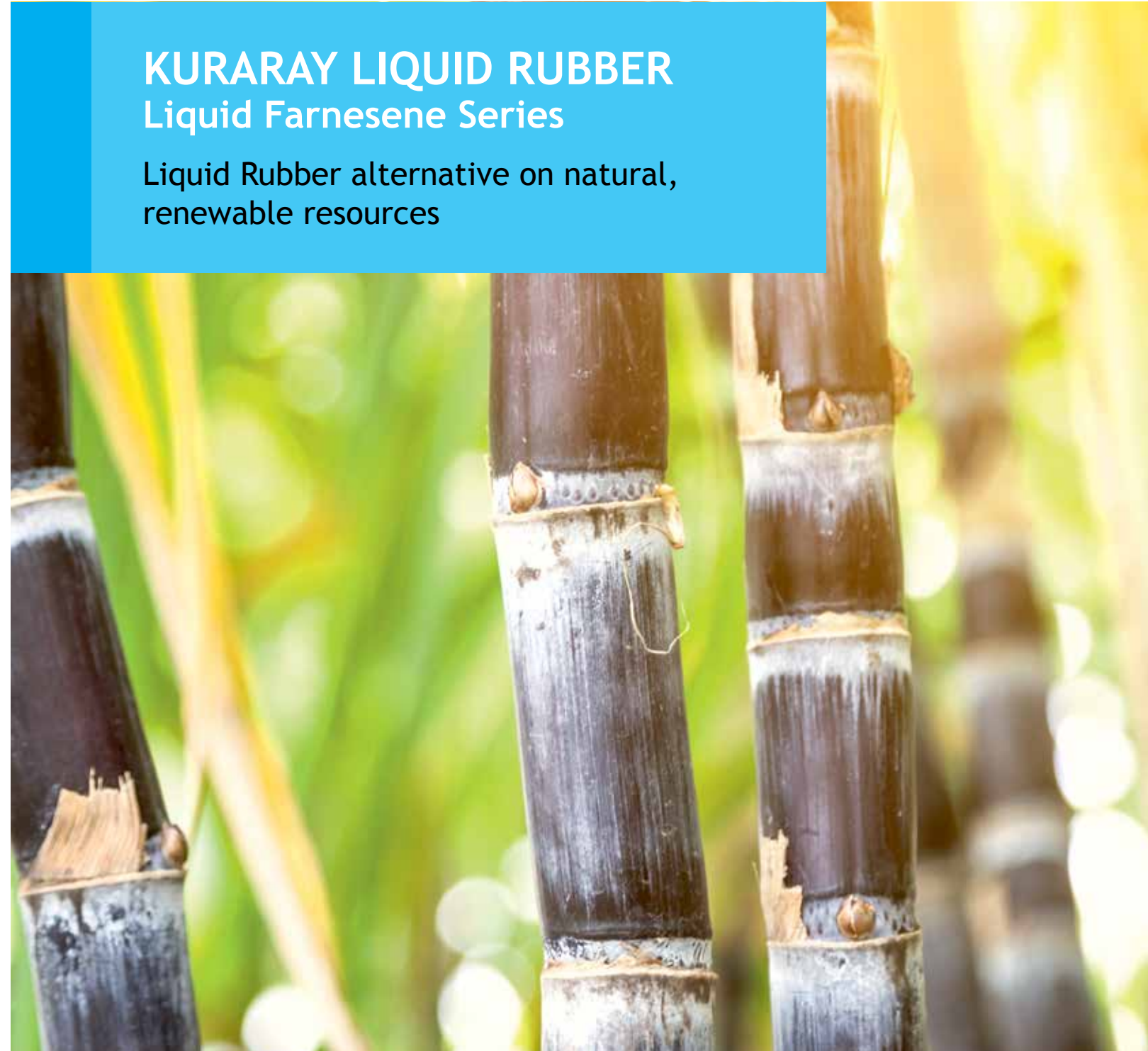
#### Kuraray Trading (Shanghai) Co., Ltd.

Unit 2106, 2 Grand Gateway  
3 Hongqiao Road, Xuhui District  
Shanghai 200030, China  
Phone: +86 21 6407 9182  
[elastomer.china@kuraray.com](mailto:elastomer.china@kuraray.com)

Disclaimer: Precautions should be taken in handling and storage. Please refer to the appropriate Safety Data Sheet for further safety information. In using KURARAY LIQUID RUBBER, please confirm related laws and regulations, and examine its safety and suitability for the application. For medical, health care and food contact applications, please contact your KURARAY LIQUID RUBBER representative for specific recommendations. KURARAY LIQUID RUBBER should not be used in any devices or materials intended for implantation in the human body. Nothing contained herein constitutes a license to practice under any patent and it should not be construed as an inducement to infringe any patent and the user is advised to take appropriate steps to be sure that any proposed use of the product will not result in patent infringement.

## KURARAY LIQUID RUBBER Liquid Farnesene Series

Liquid Rubber alternative on natural,  
renewable resources



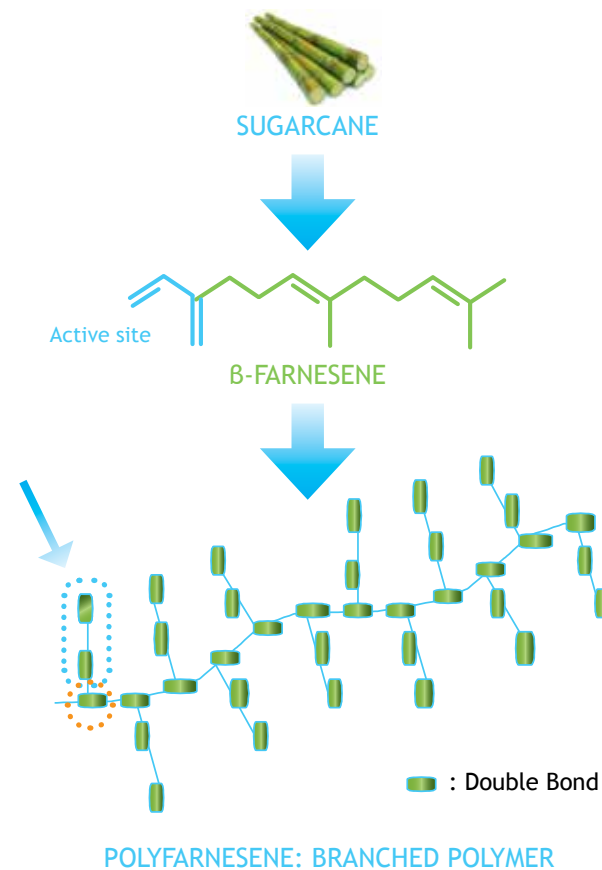
# KURARAY LIQUID RUBBER

## What is Liquid Farnesene Rubber?



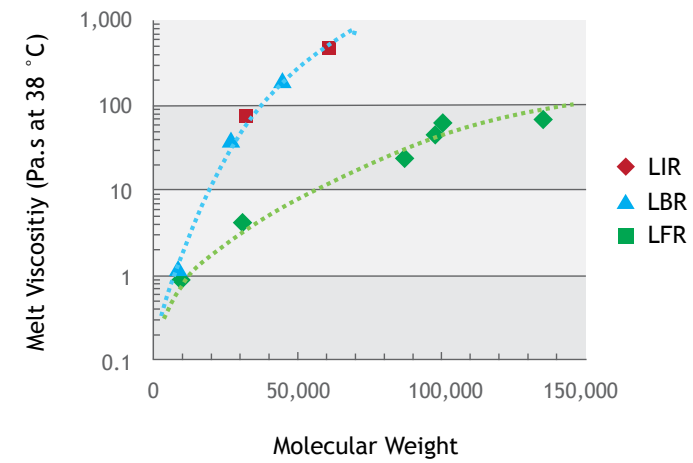
Kuraray developed a new member of their liquid rubber materials (LIR, LBR, L-SBR), called Liquid Farnesene Rubber (LFR). LFR expands the range of Kuraray's liquid rubber materials with a product based on natural and renewable raw materials. It contains a polymerized form of  $\beta$ -farnesene, a renewable monomer. Through established fermentation processes, proprietary yeast strains convert sugar sources such as sugarcane, into  $\beta$ -farnesene.

### PROCESS CHAIN FROM SUGARCANE TO LFR



### Key Advantages of LFR

- Bio-based liquid rubber alternative - on natural, renewable resources
- Lower viscosity than Liquid Isoprene Rubber (LIR) and Liquid Butadiene Rubber (LBR) because of less entanglement
- Fast vulcanization of LFR compared with LIR & LBR
- High reactivity of branched double bonds
- Co-vulcanizable characteristics prevent migration
- Improves processing properties and efficiency
- Glass transition temperature ( $T_g$ ) control enables grip control in a wide temperature range
- High molecular weight & low viscosity



LFR is a product of the KURARAY LIQUID RUBBER series. Kuraray's liquid rubber grades function as reactive plasticizers but have far higher molecular weight than normal plasticizers. They are co-vulcanizable and reduce migration significantly, which improves the durability of rubber compounds. Using KURARAY LIQUID RUBBER during the rubber compounding phase significantly reduces processing time while maintaining the rubber compounds' physical properties. This results in lower processing costs.

### Grades & Typical Properties

Grade	Type	Molecular Weight	Viscosity (Pa.s at 38 °C)	Glass Transition Temp. (°C)
L-FR-107L	Farnesene Homopolymer	130,000	69	-70
L-FBR-742	Farnesene/Butadiene Random Copolymer	30,000	12	-78
L-FBR-746	Farnesene/Butadiene Random Copolymer	100,000	603	-78

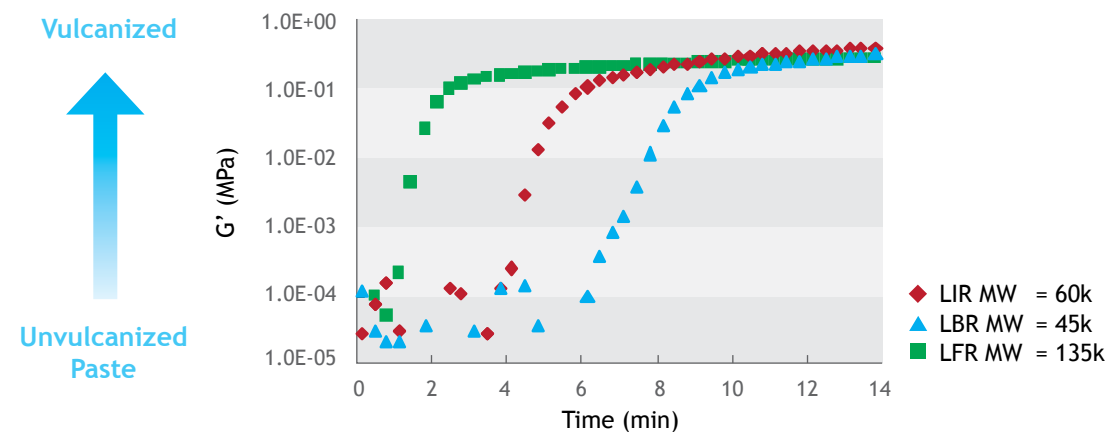
### LFR in Tires



#### LFR is a favored component in the production of high performance tires

The polymerized form of bio-based farnesene has unique properties. Its viscosity is much lower compared to current liquid isoprene rubber. When used as an additive in rubber compounds, it imparts high plasticity. In addition, it maintains excellent flexibility even at low temperatures and improves ice grip performance.

Thanks to its optimum molecular weight, LFR reacts completely with the solid rubber during vulcanization. In contrast to oil, which migrates to the rubber's surface over time and thus prevents it from softening, LFR remains fixed in rubber compounds. Therefore, the performance of the tire stays stable for a very long time.



**Formulation**  
Liquid Rubber 100,  
ZnO 2, SA 1, AO 1,  
S3, DM 1.5, DT 0.5

**DMA conditions**  
Frequency: 10 Hz  
Strain: 5.0 %  
Temp: 125 °C

- LIR MW = 60k
- LBR MW = 45k
- LFR MW = 135k