

TOYO TIRE TALK

Subject: Rubber Compound ... Polymers

As you will all know well, a tire is mainly made of "rubber" and cords. In the past, we have talked about the important functions of cords. Therefore, this time we would like to talk about the most important material in tires "rubber". When we talk about rubber, we generally mean the rubber compound to be exact.

The compound is made by mixing polymer, reinforcement material, softener and various chemicals. Different characteristics are required for every type of tire or tire part. For example, a TBR tire requires heat, wear and cut resistance for the tread rubber, while the sidewall requires good weather resistance. We therefore need many kinds of rubber compounds.

In this chapter, we'll talk about polymers, their types, characteristics and uses, that all perform very important functions.

The main polymers used for tires are as follows :

- 1) Natural Rubber (NR)
- 2) Styrene Butadiene Rubber (SBR)
- 3) Butadiene Rubber (BR)
- 4) Isoprene Rubber (IR)
- 5) Halogenated Butyl Rubber

All of the above are synthetic rubber except Natural Rubber of course.

1) Natural Rubber (NR)

NR is made from latex taken from rubber trees, mainly grown in Southeast Asia. Although there are now various kinds of synthetic rubber available, Natural Rubber is still used extensively in tires.

Characteristics

Advantage	Disadvantage
Tear Strength Wear Resistance Impact Resilience Low Heat Generation	Uniformity of quality Aging Resistance Fatigue Resistance Ozone Resistance

2) Styrene Butadiene Rubber (SBR)

SBR is now the most common synthetic rubber being used in tires. It is made by polymerizing Styrene and Butadiene together, it is also possible by changing Styrene content and polymerization process to make various types of SBR's with different characteristics.

Characteristics

Advantage	Disadvantage
Processability Uniform quality Aging by heat Frictional Force	Impact Resilience Heat Generation

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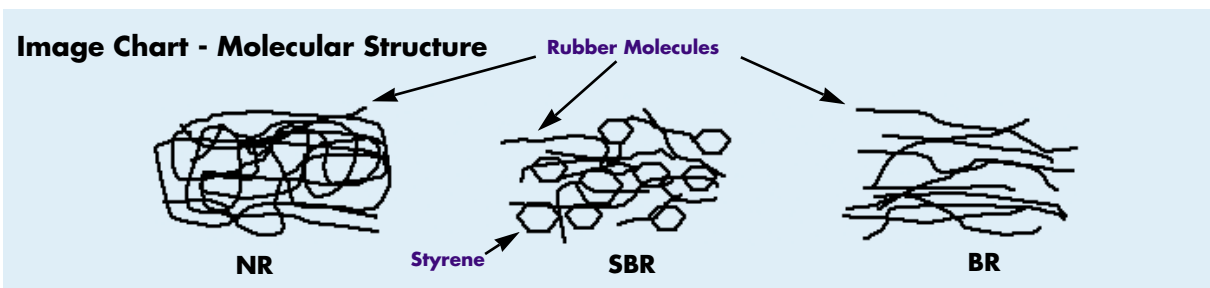
3) Butadiene Rubber (BR)

Like SBR, BR is a common synthetic rubber used in tires. However unlike NR or SBR there is less interaction among the molecules, and for this reason, a compound of BR only or high BR content has high flexibility but poor elongation resistance. BR

however has good resistance to both wear and low-temperatures and therefore is generally used by mixing with either NR or SBR to compensate for its disadvantages.

Characteristics

Advantage	Disadvantage
Impact Resilience Wear Resistance Low Temperature Property Fatigue Resistance	Tear Strength



4) Isoprene Rubber (IR)

IR is produced by artificially synthesizing Isoprene which is a principle constituent of NR. Its characteristics are naturally quite similar to those of NR. The main difference between the two being, that the quality of IR is more consistent than NR since it does not contain natural impurities. The downside however is the cost is higher than NR.

5) Halogenated Butyl Rubber

Halogenated Butyl Rubber is made by halogenating (adding chlorine or bromine) to Butyl Rubber. The molecular structure of Butyl Rubber gives a high air impermeability. Its disadvantage is it needs a long vulcanization time, however by halogenated the Butyl Rubber this can be overcome.

Characteristics

Advantage	Disadvantage
High Air Impermeability Ozone Resistance Fatigue Resistance	Impact Resilience Heat Generation Adhesion

Main Use for Tire

- | | |
|------------------------------------|---------------------------------|
| 1). Natural Rubber (NR) | ...General Use, TB Tread |
| 2). Styrene Butadiene Rubber (SBR) | ...PC Tread |
| 3). Butadiene Rubber (BR) | ...Sidewall |
| 4). Isoprene Rubber (IR) | ...Partially Used to Replace NR |
| 5). Halogenated Butyl Rubber | ...Inner Liner |

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The Characteristics of Various Polymer

Polymer	Natural Rubber / Isoprene Rubber	Styrene Butadiene Rubber	Butadiene Rubber	Halogenated Butyl Rubber
Impact Resilience	○	△	◎	×
Tear Strength	◎	×	△	△
Wear Resistance	◎	○	◎	△
Fatigue Resistance	△	△	○	◎
Aging Resistance	△	○	○	◎
Weather Resistance	△	○	○	◎
Ozone Resistance	×	×	○	◎
High Air Impermeability	×	×	×	◎

◎: Excellent ○: Good △: Fair ×: Inferior

Use for Tire

PC	Tread (Cap)	○	○	○	
	Tread (Base)	○	○	○	
	Sidewall	○		○	
	Belt	○			
	Carcass Ply	○	○		
	Inner Liner	○	○		○
TB	Tread (Cap)	○	○	○	
	Tread (Base)	○			
	Sidewall	○		○	
	Belt	○			
	Carcass Ply	○	○		
	Inner Liner	○			○