

Realizing rapid improvements in fuel efficiency for truck and bus tires  
**Advancement of Nano Balance Technology**

Hyogo, Japan – March 12, 2018 – Toyo Tire & Rubber Co., LTD. (HQ: Itami, Hyogo Prefecture, President & CEO : Takashi Shimizu) aims to develop high-performance tires that can meet the requirements of society, and it is continuously working on technology innovation of "Nano Balance Technology", the indigenous rubber material development technology developed in 2011.

We are pleased to inform you that we have developed a new process development technology contributing to significant reduction in fuel consumption from the "nano processing" aspect of Nano Balance Technology, which is one of the fundamental technology systems for the rubber used in truck and bus tires.

■ **Nano Balance Technology**

Nano Balance Technology is a technology for developing ideal rubber materials with high precision through observation, prediction, material design and production control at the molecular (nano) level.

We use this to achieve a high level of tire rolling resistance (low fuel consumption performance) and braking performance (wet grip performance). In addition to launching the fuel-efficient tire brand "NANOENERGY" which balances these two contradictory levels of performance at a high level, we also use it in our Flagship brand "PROXES", thereby offering a range of high value-added products. Moreover, even in trucks and bus tires, we have launched a series of products made by using low fuel consumption tread having excellent heat generation based on the material design technology of Nano Balance Technology.

[Fuel-efficient tires utilizing Nano Balance Technology]



NANOENERGY 0, the fuel-efficient vehicle tires rated "AAA-a" per the globally recognized labeling system.

PROXES Sport, the global class highly fuel-efficient sports tire equipped with the revolutionary Nano Balance Technology.

NANOENERGY M676, the all-weather fuel-efficient truck and bus tire with rolling resistance reduced by 31% and longevity increased by 18% compared to previous products.

## ■ Aiming for advanced truck and bus tires to answer social needs

These days, the transportation devices that are the backbone of our social infrastructure must face environmental regulation, and deal with the subject of improving transportation efficiency. Improving fuel efficiency and sufficiency in longevity for the truck and bus tires used in transportation vehicles is thought to be one way to resolve such issues.

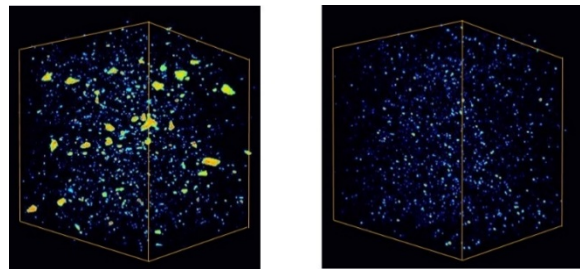
For further improvement in fuel economy of the current truck/bus tires, in order to achieve balance between rubber characteristics of low energy loss/high wear resistance, which is a problem, the key would be "How to disperse the filler in rubber". Because of this, we have been examining the possibility of making improvements in the manufacturing process in all directions.

## ■ Establishing new nano process technology with advanced filler dispersal

We have used transmission electron microscope and SPring-8 and we have analyzed dispersibility of filler present in rubber used for manufacturing tires. Regarding the natural rubber used in truck and bus tires, even if rubber compound is blended with a mixer (mixing the solid rubber and the filler), the filler cannot be uniformly dispersed in the solid rubber that is mainly used and it remains in the forms of agglomerate. When dynamic deformation is applied to this state, energy loss occurs due to contact of the fillers, etc, which becomes the main cause that adversely affects fuel economy.

For high level dispersion of filler in the compound, we have developed and established a new nano process technology that optimizes the filler structure in the solid rubber before preparing the compound. From this, our processing method achieves the ideal state of filler where it is uniformly and highly dispersed even in solid rubber like natural rubber.

Our newly-developed nano process disintegrates carbon black in a special solution and disperses it at the molecular level in the initial compound creation process while stirring and coagulating natural rubber latex. We have further optimized this process so that we can achieve our goal of "formation of highly dispersed filler at the molecular level".



Particle dispersion state of filler (left: conventional process/right: new process)

## ■ 20% reduction in the energy loss as compared with the past, practical application in Malaysia at the end of this year

We have made improvements by focusing on the processing techniques of materials, and recently, we have succeeded in developing a rubber compound that can suppress the energy loss ( $\tan\delta^{*1}$ ) at the time of deformation by about 20% even in a rubber based compound made by using natural rubber etc.



\*1)  $\tan\delta$  Value obtained by dividing the loss elastic modulus when a sinusoidal wave is applied to a viscoelastic body such as rubber with the storage modulus.

As for this advanced Nano Balance Technology, we have set up an R&D facility building with the premises of our tire factory in Malaysia, where we have already completed R&D and demonstration. In this summer, we plan to develop it as a production line, and within this year, we plan to commercialize the development and production of new truck and bus tires.

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