Fuel-efficient Tire Development by Complimentary use of Quantum Beam and Supercomputer

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The performance traits sought in tires are becoming increasingly diversified in keeping with recently heightened awareness of safety and environmental friendliness. We now know that tire rolling resistance accounts for approximately 20% of an automobile's fuel consumption. At the same time, however, tire grip strength is produced as a result of friction resistance between a tire and the road and, when tire rolling-resistance is reduced in order to improve fuel efficiency, it naturally follows that grip strength will also decrease as a result. In other words, because reduced rolling resistance and high grip strength are contradictory performance traits, in order to reconcile them, it is necessary to elucidate the mechanisms behind the expression of viscoelastic properties in tire rubber materials and to develop new materials accordingly. Thus, these challenges have become major research and development themes within the tire industry. As previously mentioned, rubber material is composed of hierarchical structures with hundreds of layers across the nanometer through micron scale, and the interactions between the structures of these various layers are extremely complex. Moreover, the dynamic motion of these structures across hundreds of different time scales gives tire rubber its fuel efficiency, wet grip performance, strength and other performance traits.

In this study, Combining the cutting-edge capabilities of the SPring-8 and the J-PARC to analyze the behavior of rubber through experiments, we have succeeded for the first time in capturing the heretofore unseen structures and behavior of polymer at the silica interface, the heterogeneity of sulfur crosslinking and the behavior of silica networks. Further, utilizing the processing power of the K computer to analyze the data so obtained, we are now able to run large-scale simulations at the molecular scale, making it possible to identify the locations of stress and heat generation within rubber. As a result, we attained "AAA-a" in the labeling system, the highest grade of rolling resistance and wet grip performance, while successfully improving wear resistance 51% compared to conventional products.

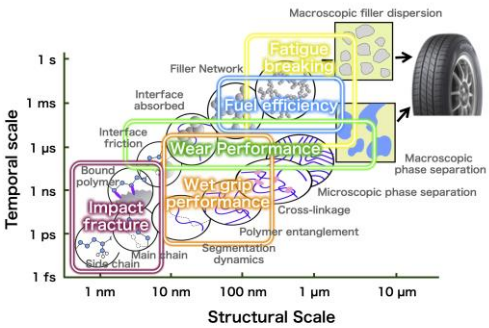

Figure 1 The Relationship between the Temporal-Spatial Hierarchical Structures within Rubber Materials and (Predicted) Tire Performance

Bibliography

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