# Evolution of Studless Tires

Observing grip performance on ice using X-rays

Research method


Beamline used at SPring-8: Engineering Science Research I (BL19B2)

## Achievements

- Confirmation of the mechanism of improving grip performance by observing the behavior of **studless tires*** containing glass fibers on ice
- Development of a new tire with ceramic **tetrapicks**** improved grip performance on ice by 30%

R&D facility: Sumitomo Rubber Industries, Ltd.

***Studless tire:** Spike tires with studs were previously used to achieve a satisfactory grip on ice. However, they damage road surfaces, and flying particles adversely affect human health leading to their banning from the market. Studless tires were produced by removing the studs from the spike tires. In recent years, the grip performance of studless tires has become outstanding not only because of the addition of glass fibers but also the increased viscosity of tire rubber and grooving of the tire surfaces.

****Tetrapick:** A tetrapod-shaped acicular inorganic compound. A tetrapick is approximately 20 μm in size and has the high strength unique to single crystals.

## Role of SPring-8

### Background

The grip performance of studless tires with added glass fibers was previously evaluated by simulation and running tests using actual vehicles. In order to improve the grip performance, it is necessary to continuously observe the glass fibers coming into contact with and breaking the ice (**the scratching effect**) and to examine the mechanism underlying grip performance.

However, ordinary X-rays are transmitted through tire rubber, glass fibers, and ice in almost the same manner. Therefore, it was not possible to distinguish these three substances in X-ray images.

### Results

The highly parallel X-rays at SPring-8 enabled us to detect the difference among tire rubber, glass fibers, and ice from the slight differences in their refractive indices and to obtain animated images with clear boundaries. The mechanism of grip performance by the effect of glass fibers was clarified from these images.

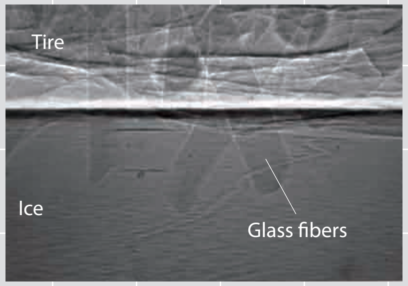
In addition, we developed a new tire with tetrapicks, which can induce the microscale scratching effect, observed the three-dimensional dispersion state of tetrapicks by **high-resolution X-ray CT**, and clarified the relationship between the dispersion state and grip performance.

We continued our research on developing tires with the scratching effect of both glass fibers and tetrapicks using these results. We consequently commercialized studless tires with high grip performance.

### Scratching effect of glass fibers (Animated images obtained by refraction contrast imaging with highly parallel X-rays)

Glass fibers pierce and break ice upon contact without being bent or fractured; therefore, the tire strongly grips the ice.

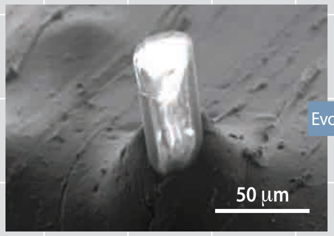
Before coming into contact with ice



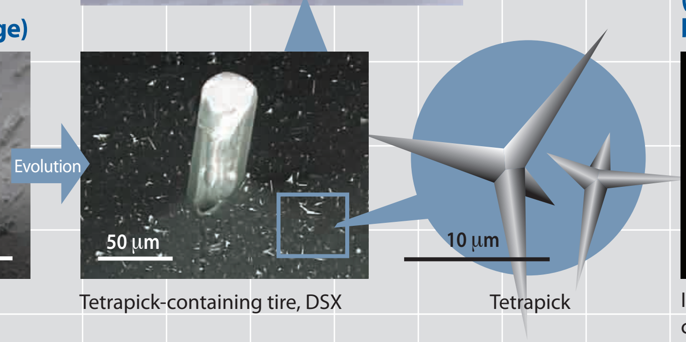

Glass fibers piercing the ice

Ice after glass fibers are removed

### Surface of studless tire (Electron microscopy image)

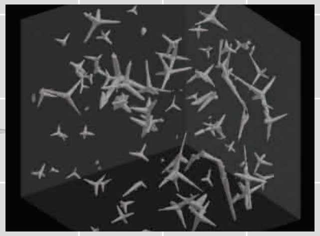



Tire containing glass fibers, DS-2




Tetrapick-containing tire, DSX

### Dispersion of tetrapicks (Photographed by high-resolution X-ray CT)



It was found that grip performance can be improved by uniformly dispersing tetrapicks in rubber.