Specific strength of materials

(1)Purpose

Humans have always yearned for strong materials and have worked diligently throughout history to create new materials. Currently, people are not just seeking strong materials, they also desire materials that possess the added value of light weight. **[1]**In the case of transportation, constructing transportation equipment using materials that possess great specific strength is the most effective method to reduce transportation costs and enhance safety. This also satisfies the national-level requirement of reducing CO_2 emissions as part of overall energy conservation efforts. Therefore, by noting the specific strength of metallic and nonmetallic materials, while taking in consideration the technology needed for combining materials, **[2]** the machine materials and materials processing division has reviewed past results and predicted future potentials. Since material development takes longer than other research fields, we will describe the transition of demand for materials that possess great specific strength beginning with the first half of the 20th century.

(2) Social and technological requirements for technical issues

Materials of great specific strength are used in various fields, including transportation equipment, architecture, medical care and social welfare. The social and technological requirements and purposes include the following:

•Demand from the fiercely competitive aircraft industry for large airframes in order to achieve low fuel consumption, and reduced noise

•Reduction of fuel consumption by automobiles for environmental protection and fuel cost curtailment

•Development of high-speed railway networks and lightweight, energy-saving train cars

• **[3]**Governmental guidance related to anti-seismic building structures and increasingly tall high-rise buildings

• Reduction of the burden on care workers by providing improved welfare and care equipment to the aged society

•Demand for improved sports equipment

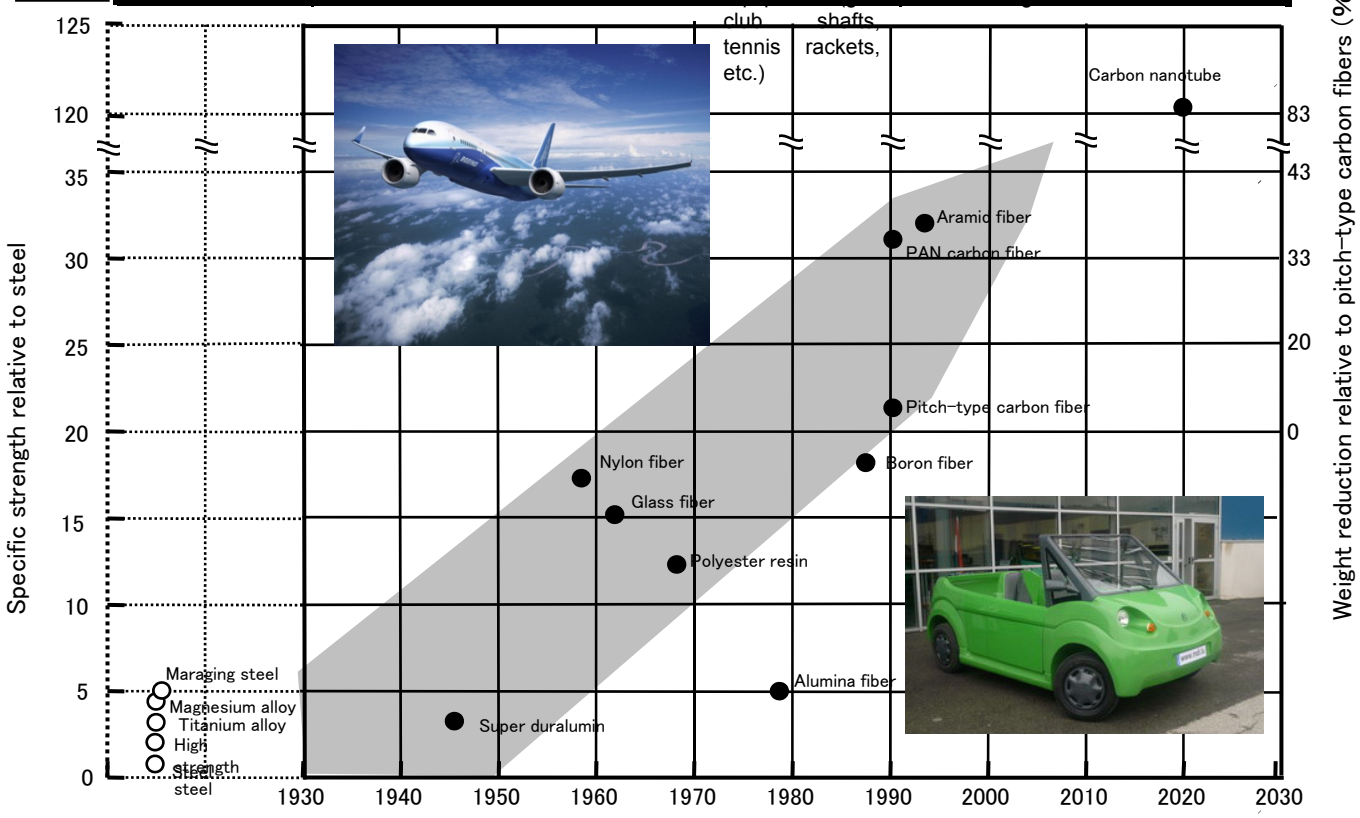
(3) Potential mechanisms that achieve high-grade key parameters

Materials that possess great specific strength were first applied to national aerospace development, medical care and sports projects, which are areas where the financial aspect is a secondary consideration. The materials then spread into general society use. To ensure the full diffusion of such materials throughout society, cost reduction is a decisive factor. If manufacturing costs can be reduced, the consumption of these materials will increase and with increased use, manufacturing costs will decline even further. In the future, further improvements to materials with specific levels of strength will be essential as a matter of course. Additionally, it will be important to improve the technology needed to combine such materials, and to develop materials that have strong thermal and environmental resistance. as well as great specific strength. Ensuring the ease of workability of these materials and eliminating any harmful effects on human involved in the manufacturing processes will also be important.

(4) Future society outlook

As part of future research and development efforts into materials that have great specific strengths, we will need to plan for their social influences by assuming they will be distributed widely among the public. In other words, we will need to develop these materials while taking into consideration what influence they will have on the global environment as well as the need to recycle such materials after they reach the end of their service life.

Social and technological requirements		・Development of military aircraft	・U.S. Apollo Project ・Development of civilian aircraft	・Advance of aircraft steel ・Advance of high-speed railway networks ・Space Shuttle Project ・Expectations toward highly functional sports equipment (golf club shafts, tennis rackets, etc.)	・Reduction of automobile fuel consumption ・Expectations toward care-related medical equipment ・Anti-seismic structures ・Increasing heights of high-rise buildings	・CO_2 reduction



Technological breakthroughs	・Development of duralumin by Wilm	・Successful synthesis of 66-Nylon by Wallace Carothers		・Invention of PAN carbon fiber by Dr. Akio Shindo ・Development of C/C carbon	・Discovery of carbon nanotubes	
Social and market changes		Restoration after the Second World War	High economic growth Mass consumption Private automobile ownership boom Automobile exhaust gas problem	First Oil Crisis Second Oil Crisis	Global warming Development of large aircraft Aged society Anti-seismic measures	Appearance of emerging countries