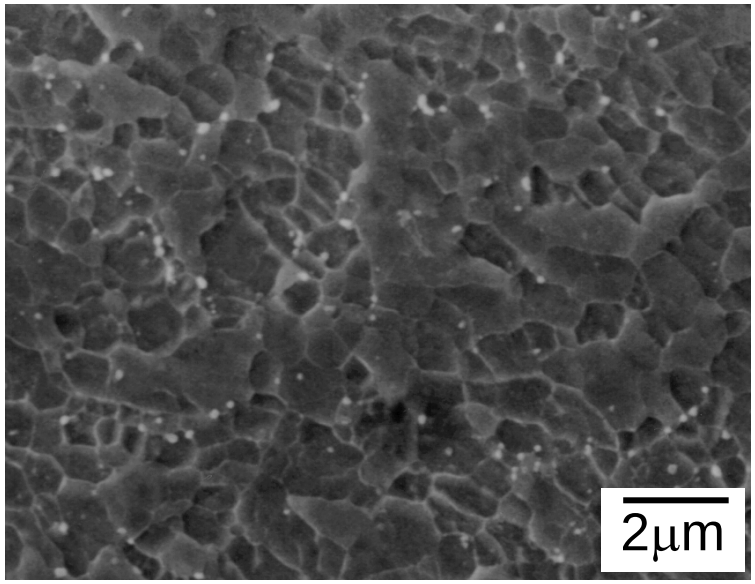
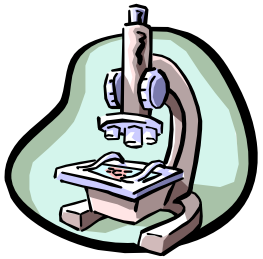
超微細粒鋼の自動車への利用可能性





自動車における課題と超微細粒鋼

CO_2, Emission, Recycling, Safety

環境問題、安全性

部品・部材のハイテン化

環境負荷物質を使わない車つくり

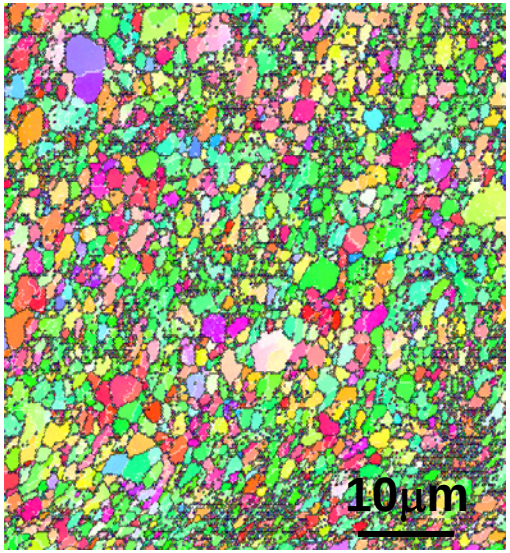
リサイクル性の高い車つくり

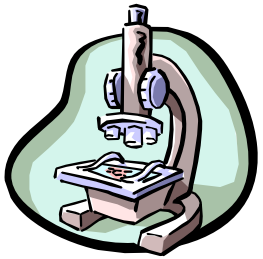
安全性の高い車つくり

先進ハイテン
Dual Phase 鋼
TRIP鋼

超微細粒鋼

希少な合金元素を使わずに結晶粒微細化によって高強度化を達成



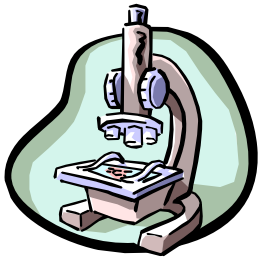


超微細粒鋼の実用化と普及のために

従来型先進ハイテンにはない、特有の魅力ある材質

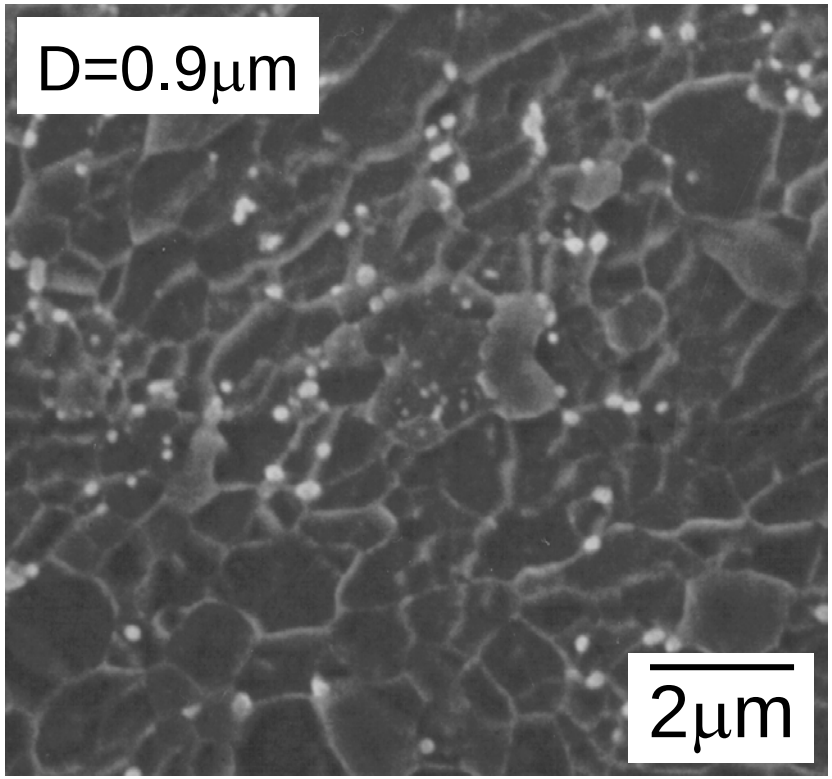
リサイクル性、溶接性、高靭性だけではなく
もっと＋αを！

疲労特性、衝撃変形特性



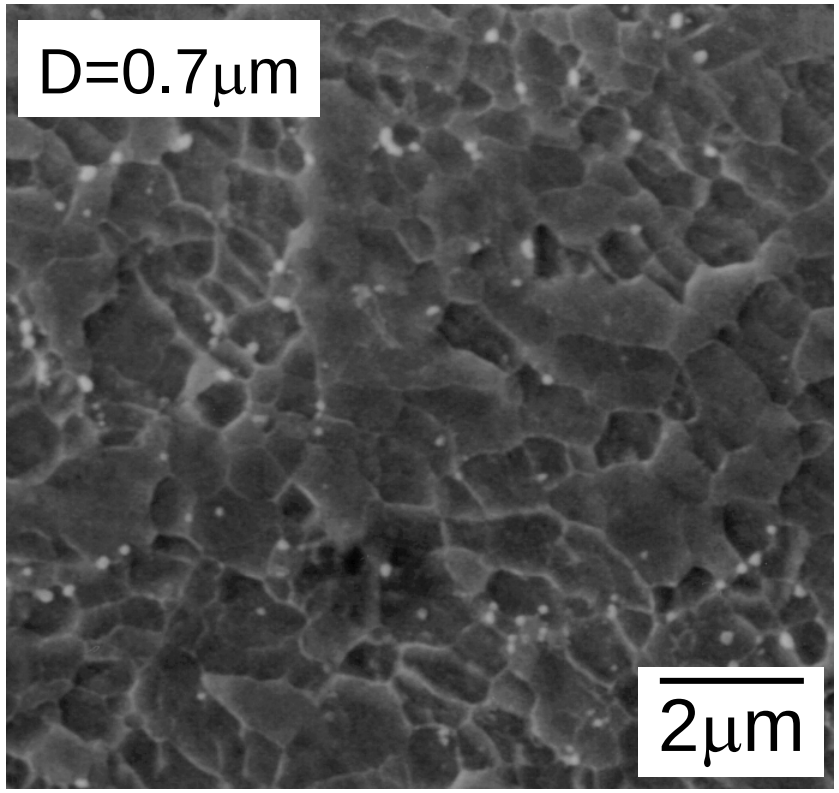
疲労特性（供試材）

0.15C-0.30Si-1.45Mn

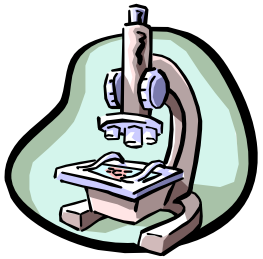


YS=658MPa, TS=668MPa

0.05C-<0.01Si-1.98Mn

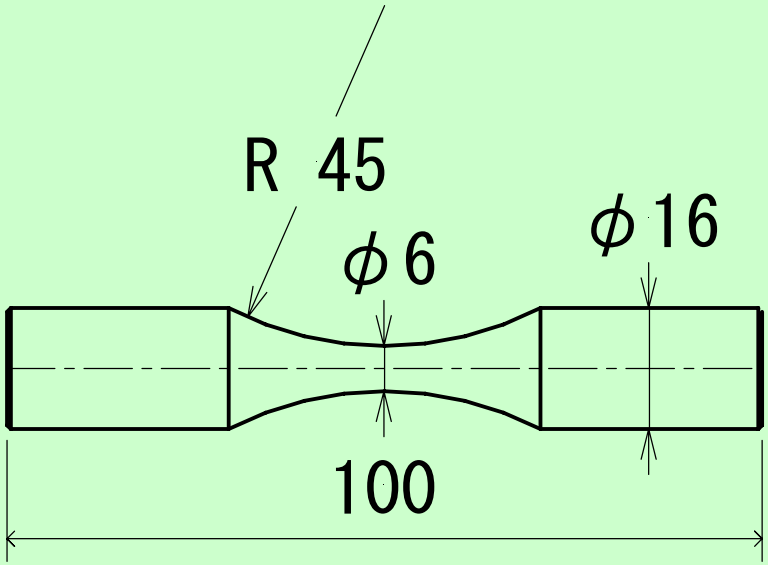


YS=645MPa, TS=645MPa

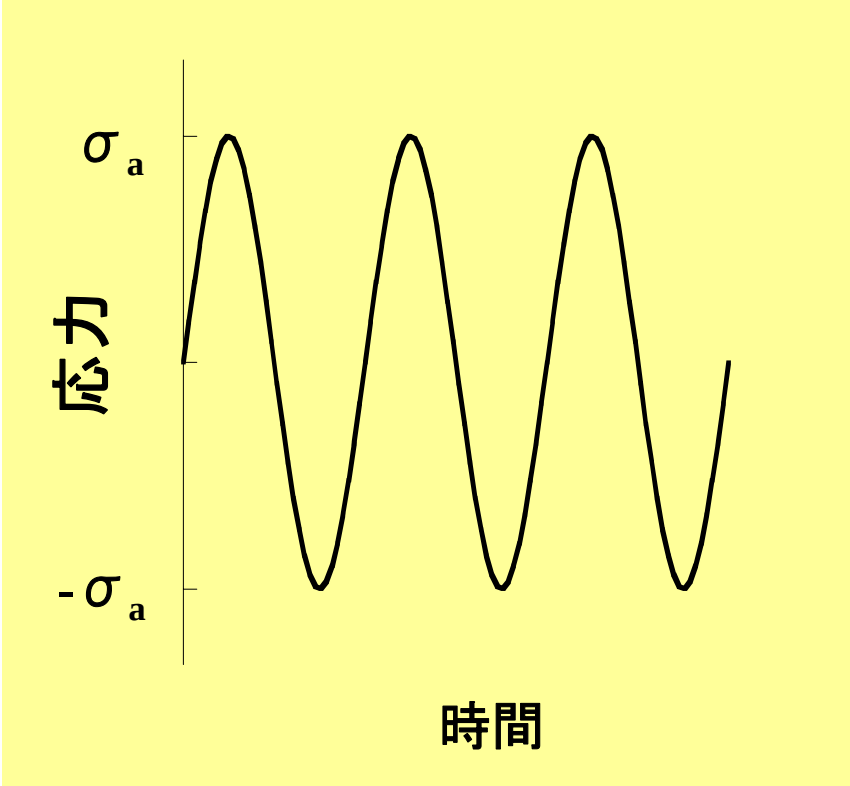


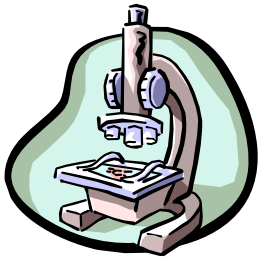
疲労特性（高サイクル試験法）

試験機　　：油圧サーボ
振幅　　：210～430MPa
応力比　R　：　−1
速度　　：10～35Hz
試験片　　：



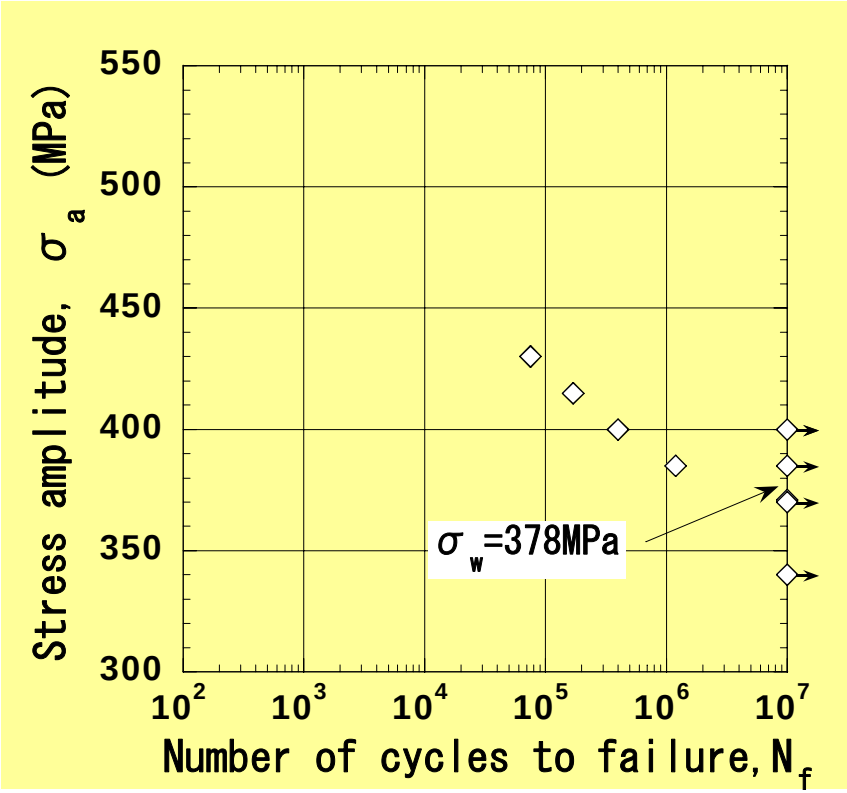
荷重制御疲労試験



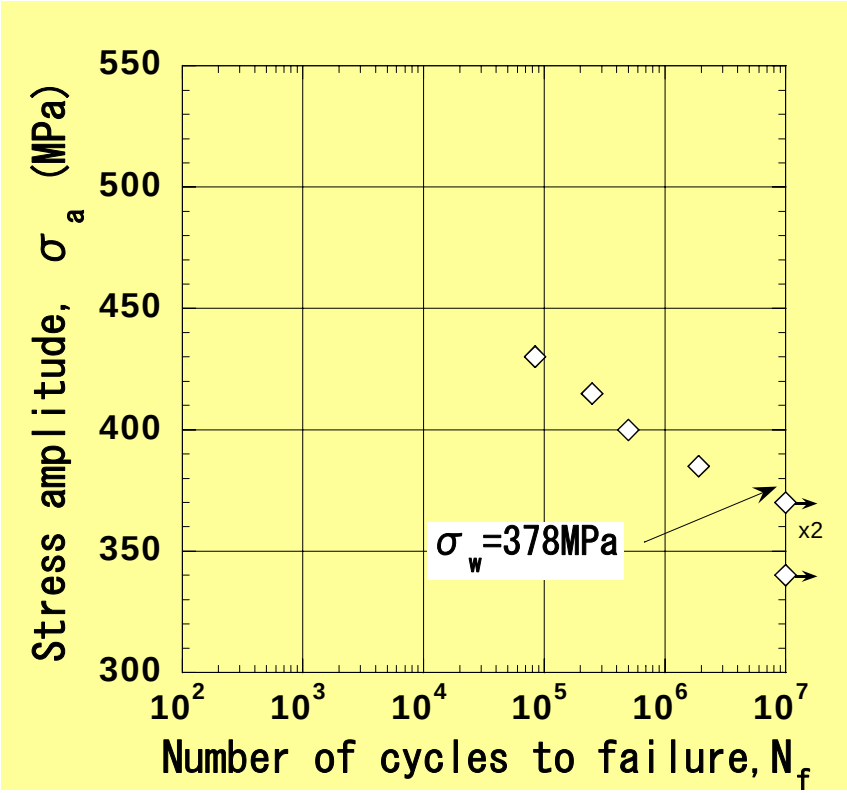


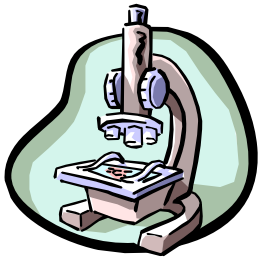
疲労特性（10^7疲労限）

0.15C-0.30Si-1.45Mn
(D=0.9μm)

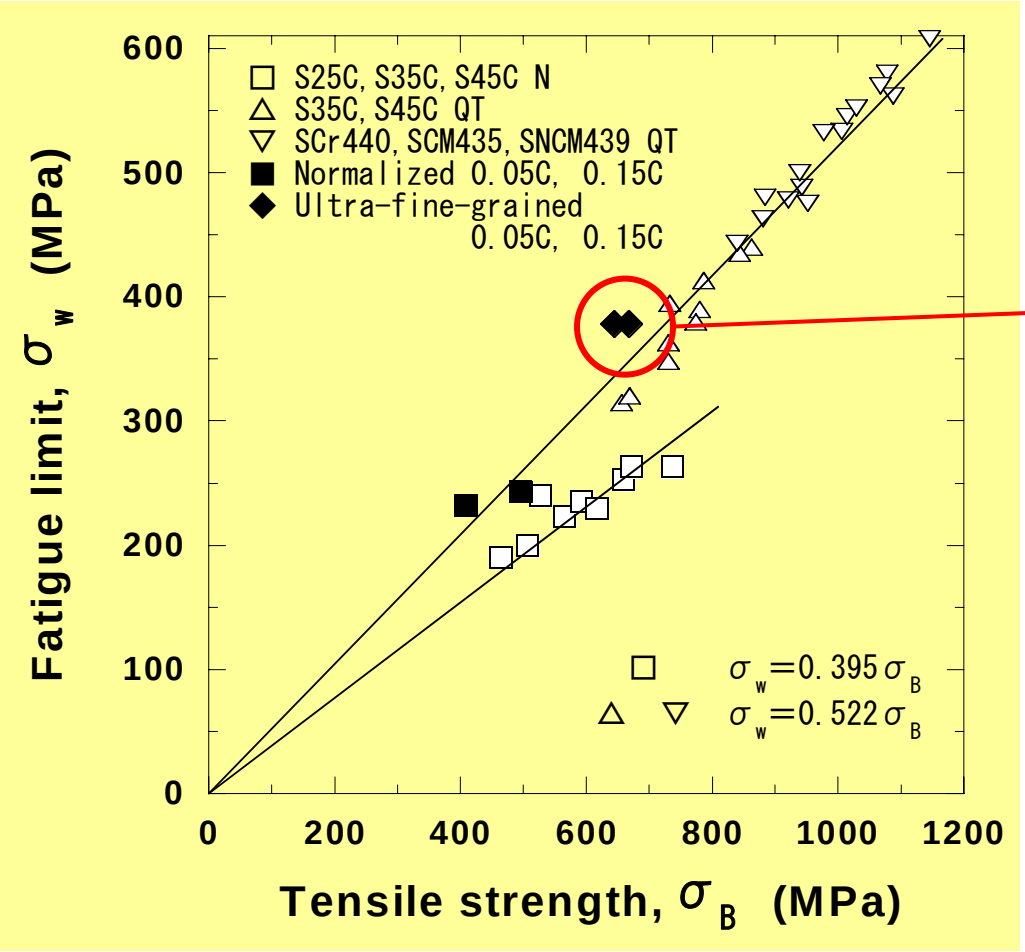


0.05C-<0.01Si-1.98Mn
(D=0.7μm)



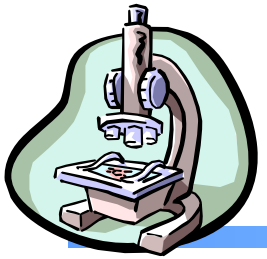


疲労特性（疲労限vs引張強度）

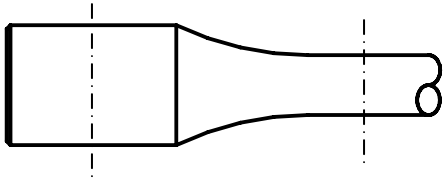


$\sigma_w = 0.55\sigma_B$

QT材と同等

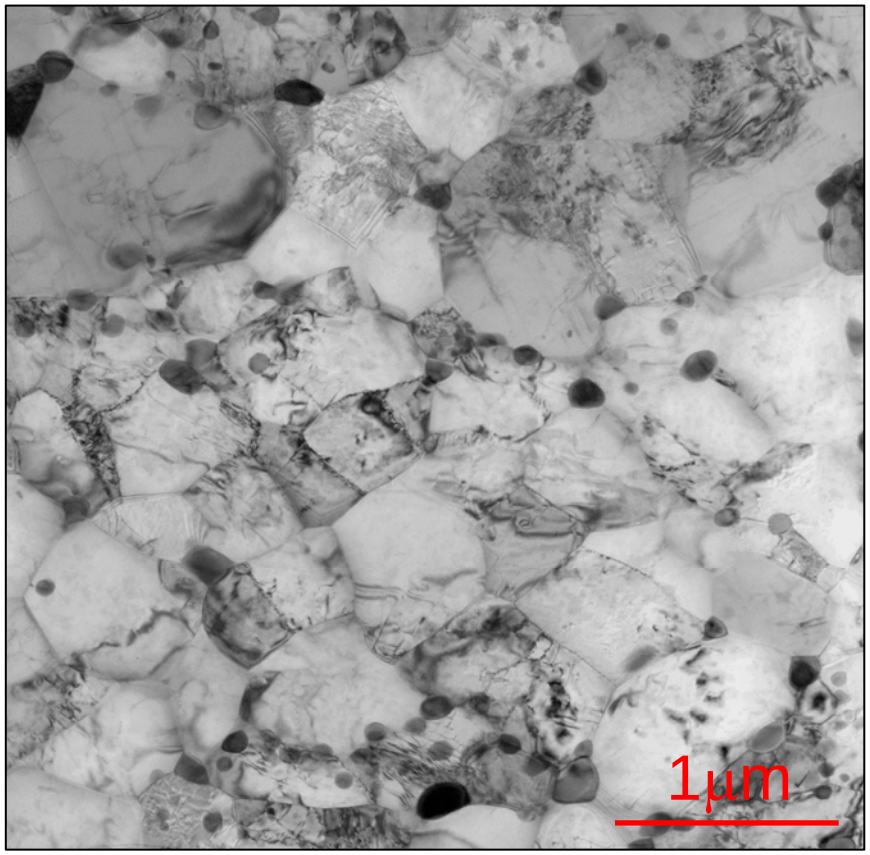


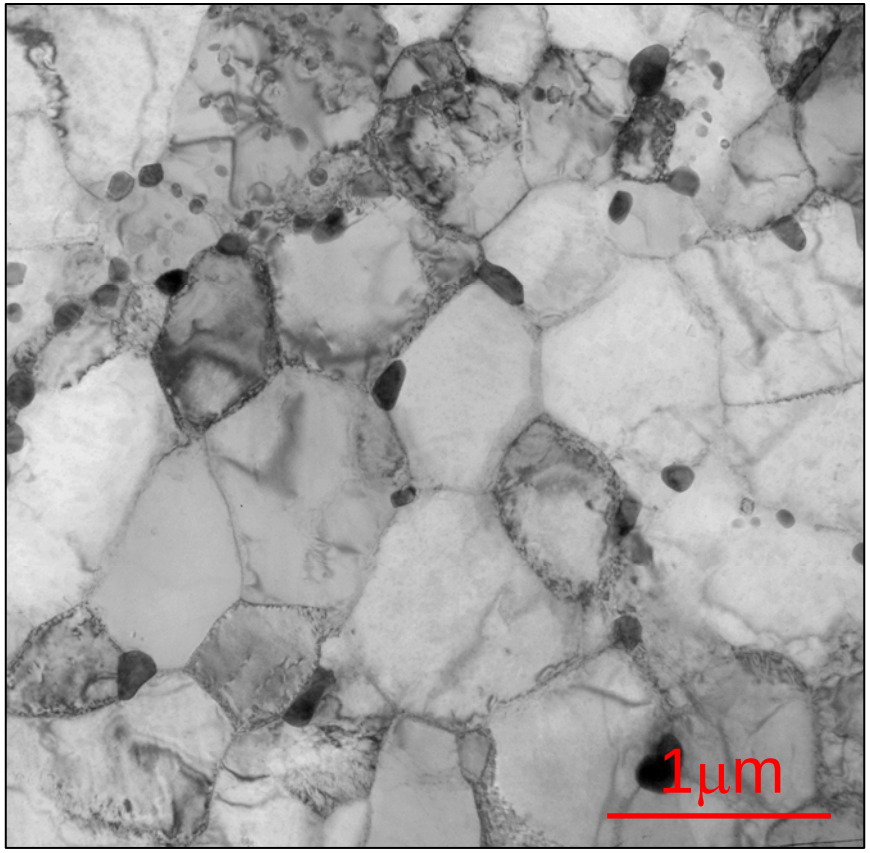
疲労特性（疲労による組織変化）

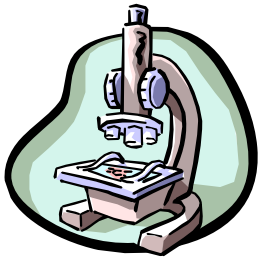


$$\varepsilon_{ta} = 1.2\%, \varepsilon_{pa} = 0.9\%, \sigma_{ta} = 536MPa, N_f = 837$$

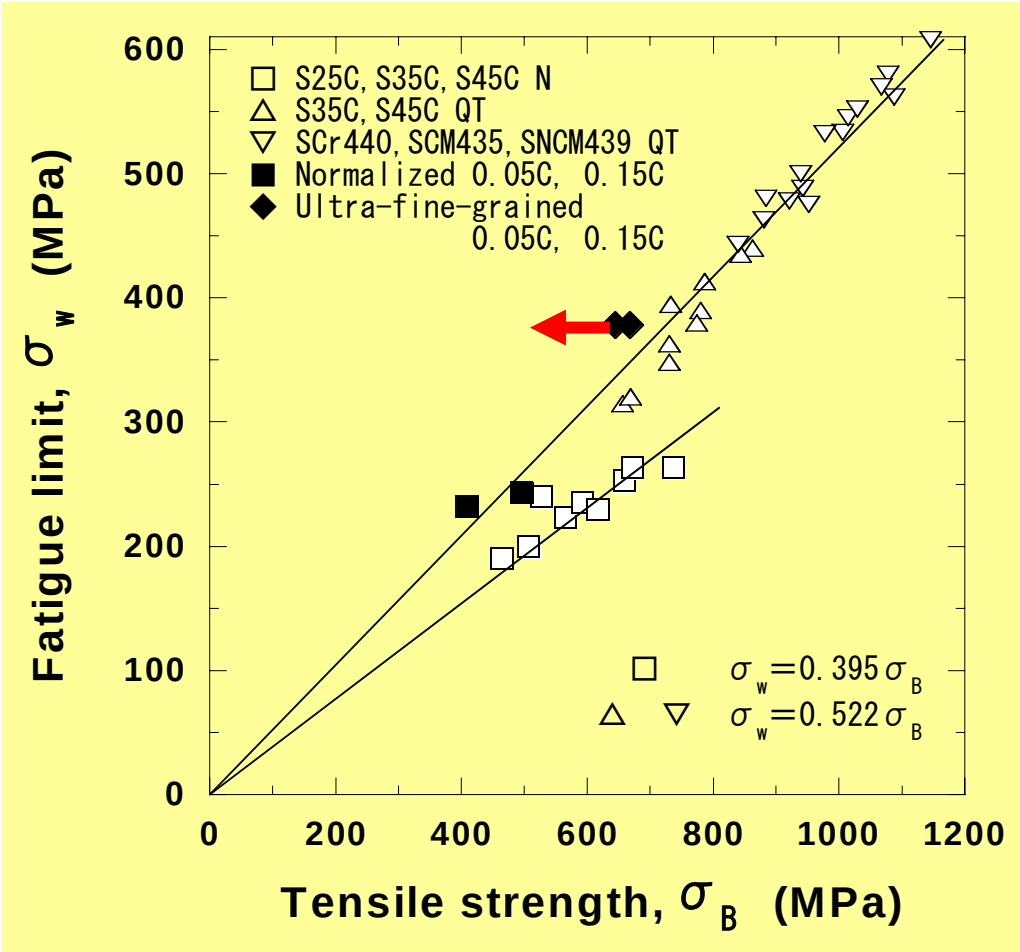
転位回復
繰り返し軟化







疲労特性（疲労限vs引張強度）



従来結果

$\sigma w = k\sigma_B$

k=0.4-0.55

回復でσ_Bは低下

K>0.6となる可能性

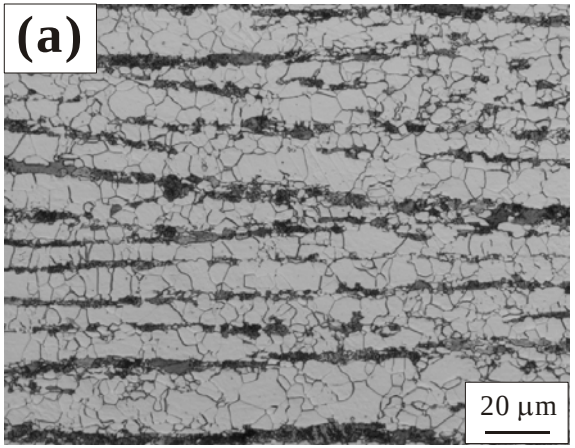
↓

TS同じで疲労限向上

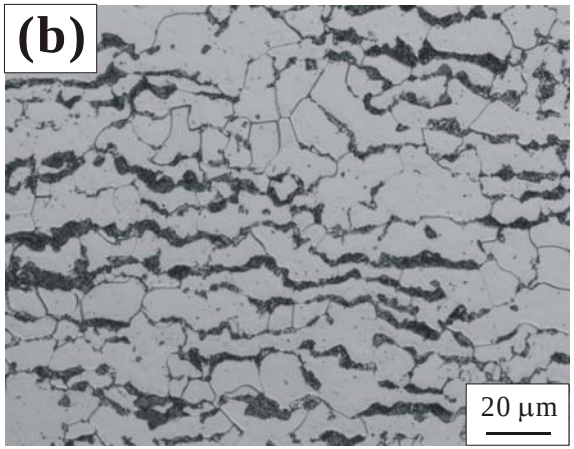
【Q】自動車部品で金属疲労が問題となる部品を示せ。

衝撃変形特性（供試材）

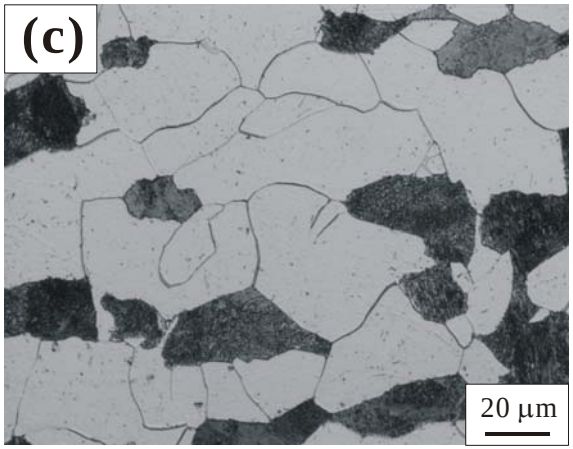
Ferrite-Pearlite Steels



D=3.6 μm



D=9.8 μm



D=46.2 μm

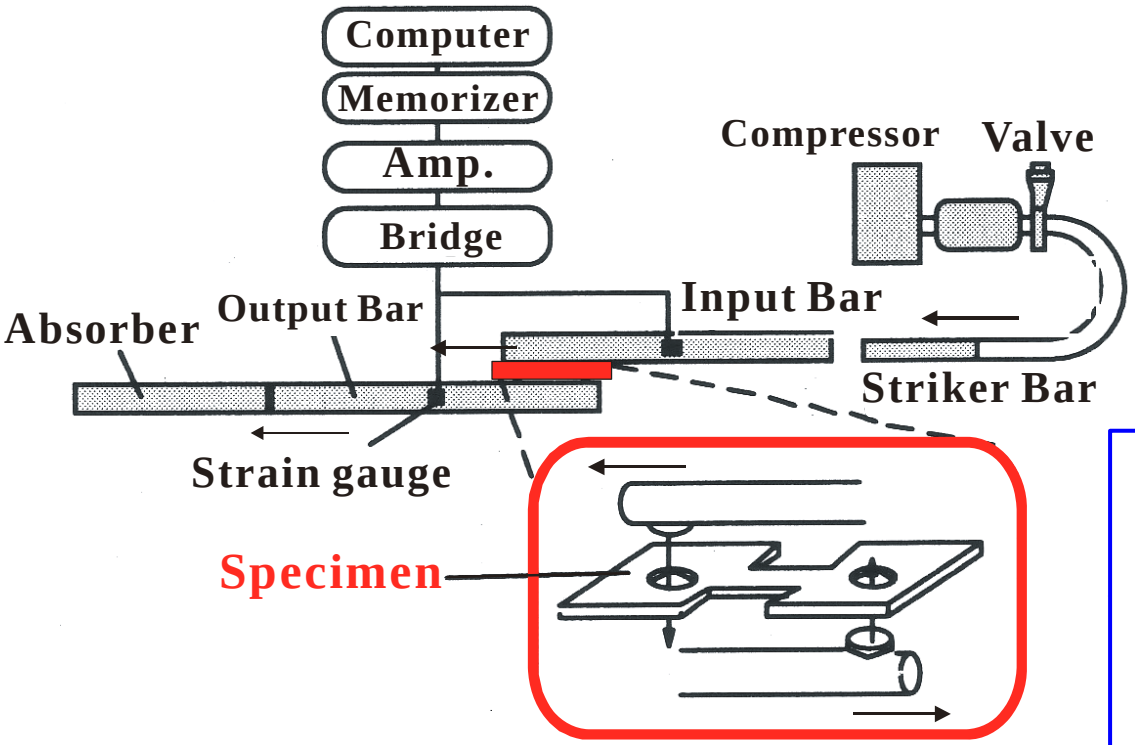
JIS-SM490 steel

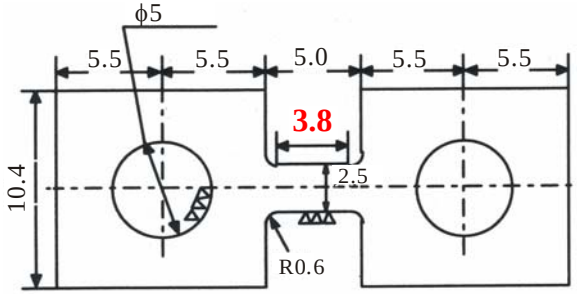
0.15C-0.4Si-1.5Mn (mass%)

Tsuchida, Tomota and Nagai: ISIJ Inter., 42 (2002), 1594-1596.

衝撃変形特性（試験方法１）

Split Hopkinson Pressure Bar Machine





Test Specimen

Strain rate $=10^3\ s^{-1}$

Temperature

296 K (Room temperature)
210 K (Methanol)
77 K (Liquid nitrogen)

衝撃変形特性（試験方法2）

Tensile Test between 10^{-6} and 10^{0} s^{-1}

below room temperature

Strain rate

10^{-6}～10^{-2} s^{-1}

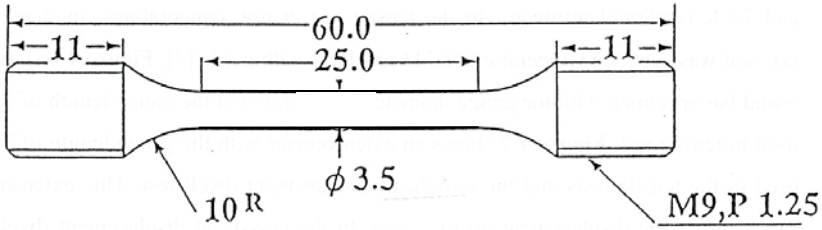
10^{-9} s^{-1}

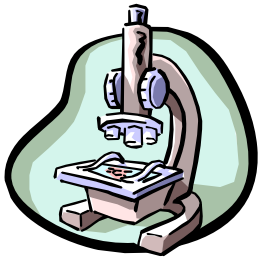
*** Crosshead arresting Test**

Strain rate

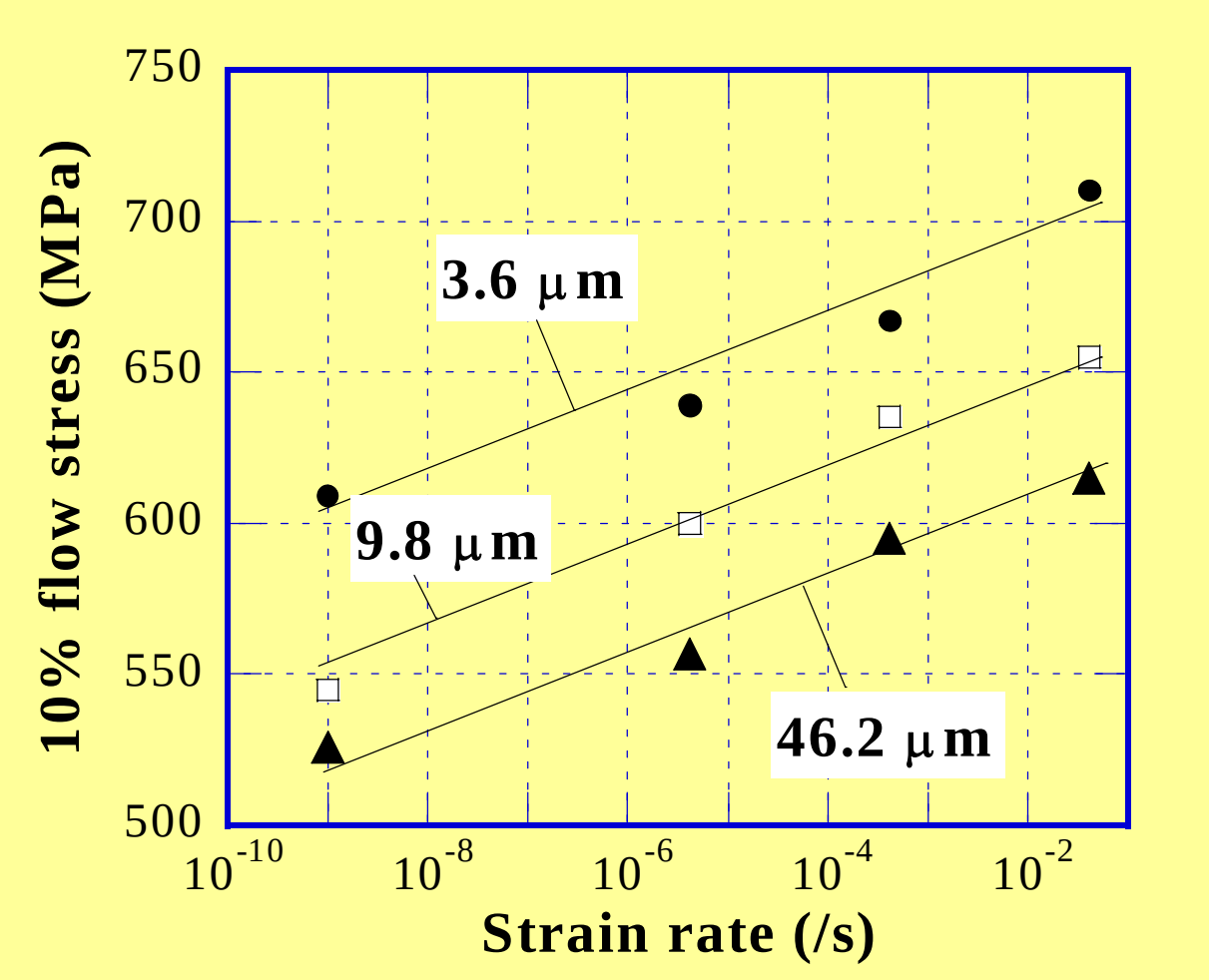
10^{0} s^{-1}

Test Specimen

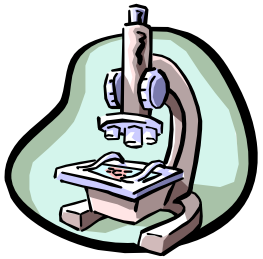




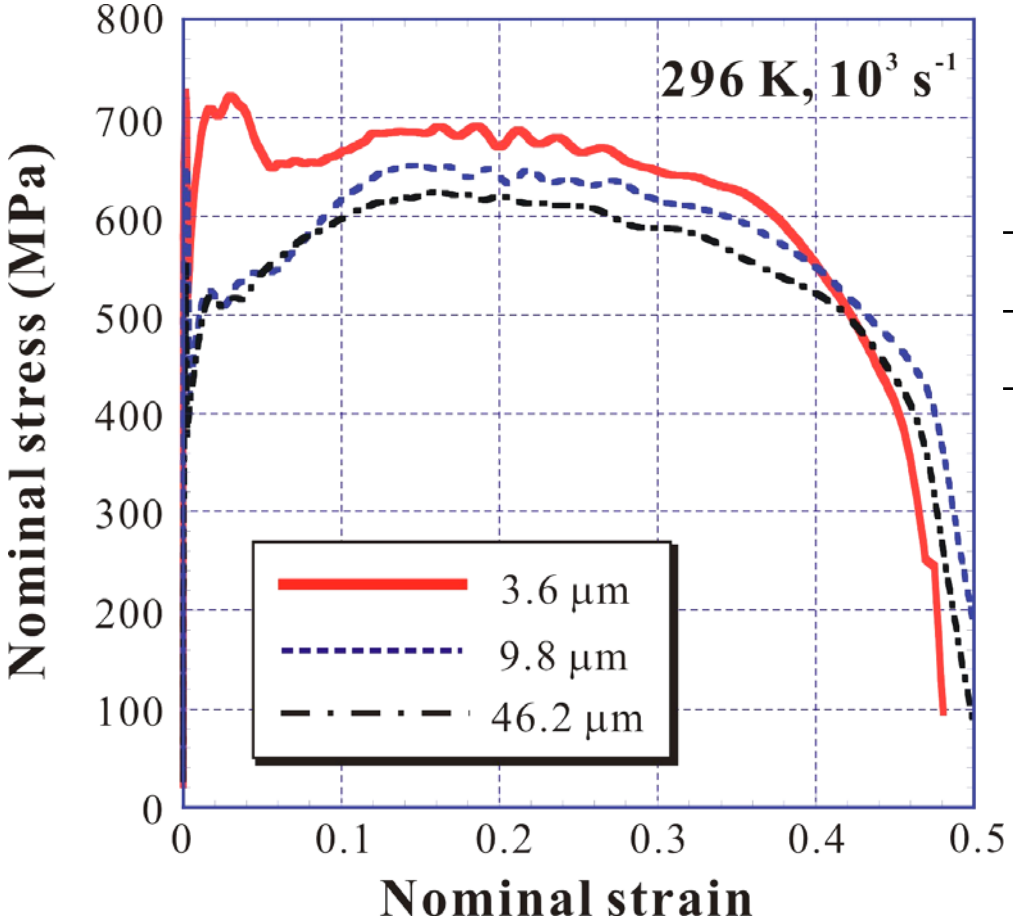
衝撃変形特性
（210 K, ひずみ速度依存性）



結晶粒微細化強化量:ひずみ速度依存性なし！



衝撃変形特性（296 K, 10^3 s^{-1}）



Tensile properties

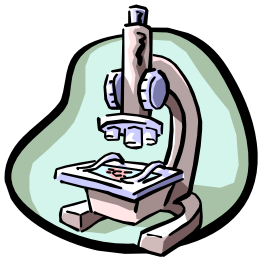
D (μm)	TS	U.El	T.El
3.6	692	18.9	46.8
9.8	648	20.0	51.0
46.2	625	16.8	49.7

TS: Tensile strength (MPa)

U.El: Uniform elongation (%)

T.El: Total elongation (%)

静動比の高い高強度鋼



超微細粒鋼の自動車への利用可能性：実用化と普及に向けて

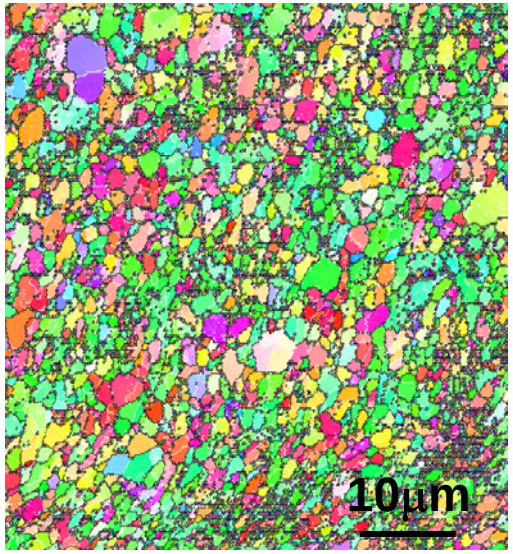
CO_2, Emission, Recycling, Safety

環境問題、安全性

部品・部材のハイテン化

超微細粒鋼

希少な合金元素を使わずに結晶粒微細化によって高強度化を達成



TS同じで疲労限向上

静動比の高い高強度鋼

もっと＋αを！

日産技報：2002, No.50, pp.33-37（坂元宏規氏）

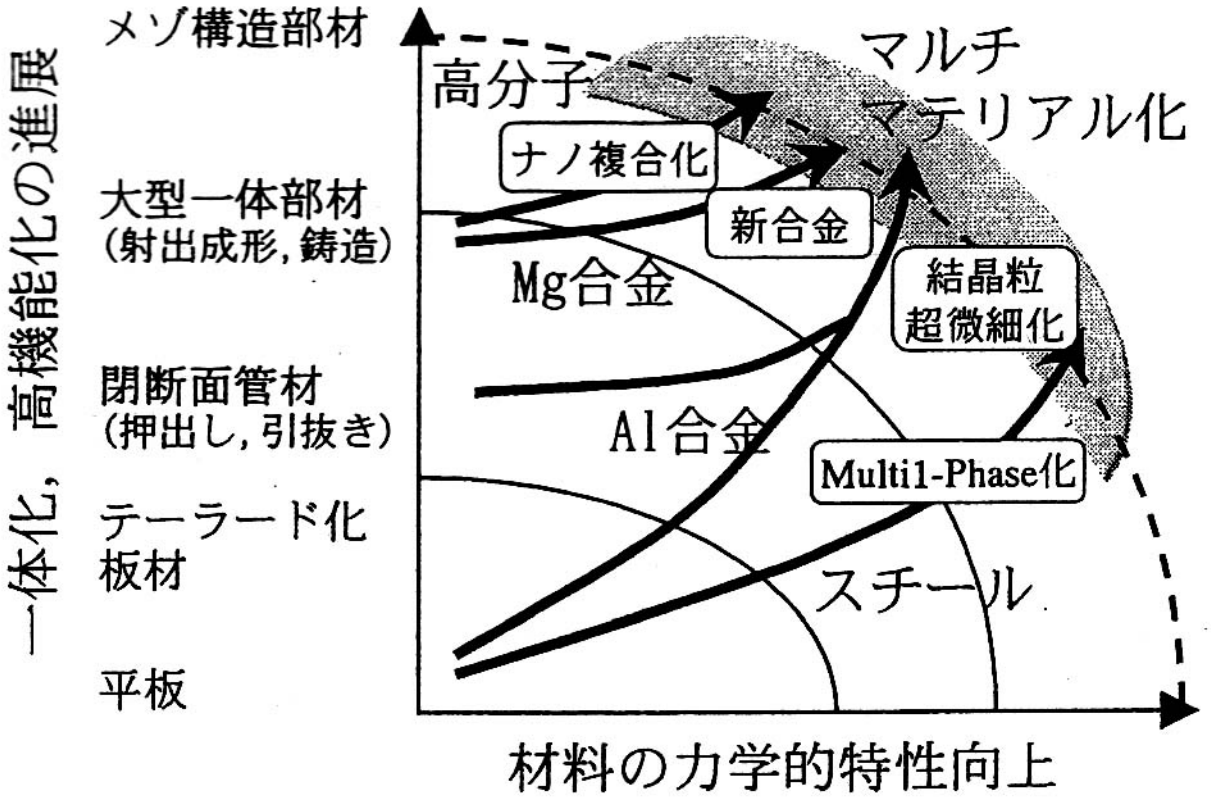


図-8　材料技術開発の方向性

スチールはさらに高強度化が進み、塑性加工性、溶接性の高さを生かした構造形成技術の進展とともに量的には車体材料の主役であり続けると考えられる。アルミニウム等の軽合金材料は、スチールを費用対効果で上回るための機能を含めた一体化技術が今後目指すべき方向と考える。その結果、最も合理的な設計としていわゆるマルチマテリアル化が進むものと考えられる。