1.2GPa Tensile Strength
High Formability, Conventionally Stamped Steel

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AGENDA

- INTRODUCTION (NISSAN’S APPROACH TO REDUCING CO$_2$)
- HIGH ELONGATION, 1.2GPa. DEV. (NEW MATERIAL DESCRIPTION)
- MICROSTRUCTURAL APPROACH AND STRENGTHENING MECHANISMS
- MECHANICAL PROPERTIES
- MANUFACTURING CAPABILITY
- APPLICATIONS
- FUTURE DIRECTION
Reduce CO$_2$ emissions of new vehicles by 90% from 2000 levels.

Achieve "CO$_2$ concentration level of 450ppm" proposed by IPCC.
NISSAN’S APPROACH TO \( \text{CO}_2 \)

15% reduction of vehicle weight contributes to \( \text{CO}_2 \) reduction of 5%

**Triple-layered approach**

- **Society**
  - Reduced traffic jam
    - Sky Project
    - Star Wings

- **Individuals**
  - Supporting eco drive
    - ECO Pedal
    - Fuel consumption meter
    - Eco drive advice

- **Vehicles**
  - EV/HEV
  - Engine/Transmission
  - Idle stop
  - Accessory loss
  - Rolling resistance
  - Air resistance
  - Heat management
  - **Vehicle weight**
Nissan’s Approach TO BIW Weight Reduction
(Three Areas are Considered)

- **MASS REDUCTION**
- **STRUCTURE RATIONALIZATION**
  - SHAPE OPTIMIZATION
  - FUNCTION ALLOCATION
  - INTEGRATION/SEPARATION OF FUNCTIONS
  - JOINING
  - MOLDING
- **MANUFACTURING**
  - MATERIAL SUBSTITUTION
    - HIGH STRENGTH MATERIALS
    - LOW SPECIFIC GRAVITY MATERIALS
Cost and Mass Reduction can be Achieved by AHSS Application
1.2GPa T.S. HIGH ELONGATION STEEL IS DEVELOPED
• High elongation 1.2 GPa steel can be applied to complex shapes.

• High elongation 1.2 GPa steel has equal or better biaxial formability than 980 MPa material.

Current Status

Next generation High tensile strength steel

High tensile strength steel

High

Low

Tensile strength

High

Low

Ductility

*HE: High Elongation

SIMPLE

COMPLEX
MICROSTRUCTURE AND STRENGTHENING MECHANISMS
HE 1.2GPa MICROSTRUCTURES – DP & TRIP (TWO APPROACHES)

(DUAL PHASE)
Conventional material

(COMPLEX PHASE)
Transformation induced plasticity

Martensite and Bainite (Strength improvement)
Retained austenite (Improving formability)
Fine ferrite (Improving formability)

FERRITE
MARTENSITE
Dual Phase vs TBF Microstructure Mechanism of Steel

**DP steel**
- Ferrite & Martensite

  Hard area and soft area coexist.

**TRIP steel**
- Retained Austenite $\rightarrow$ Martensite after force is applied.

  - Ferrite
  - Martensite

  - Austenite
  - Martensite
Deformation behavior of retained austenite phase

Blue: bcc (ferrite + banite)
Red: fcc (retained austenite)

Decreased Retained Austenite Existence until late deformation

TRIP EFFECT
(RETAINED AUSTENITE REMAINS AT HIGH DEFORMATION)
ENdERGY ABSORPTION (STRENGTH vs THICKNESS)

Drop weight test results

![Diagram showing energy absorption vs sheet thickness with data points for 980MPa-DP and 1.2GPa AHSS. 15% increase indicated.]

ENERGY (J) vs SHEET THICKNESS (mm)
THE TRIP EFFECT RESULTS IN ADDED ENERGY ABSORPTION PROVIDING ADDITIONAL STRENGTH AND CRITICAL ENERGY ABSORPTION.
MECHANICAL PROPERTIES
## Advanced High Tensile Strength Steel (AHSS)

### Mechanical Properties

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STATUS</th>
<th>T.S. (MPa)</th>
<th>Y.S.(MPa)</th>
<th>%ELONG</th>
<th>LAMBDA(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2GPa SPEC.</td>
<td>SPECIFICATION</td>
<td>1180 Min.</td>
<td>850 Min.</td>
<td>14 Min.</td>
<td>30 Min.</td>
</tr>
<tr>
<td>980MPa DP</td>
<td>SPECIFICATION</td>
<td>980 Min.</td>
<td>600 Min.</td>
<td>10 Min.</td>
<td>--</td>
</tr>
<tr>
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**NEW 1.2GPa with high formability**

**Mechanical Properties**

- **Stress (MPa)**
  - 1.2GPa
  - 980MPa
  - 590MPa
  - 440MPa
  - Mild Steel

- **Strain (%)**
  - 0 to 60
MANUFACTURING CAPABILITY
MANUFACTURING CAPABILITY – FORMING
(TRIP MATERIAL)

FLD SHOWS NEW HIGH ELONGATION 1.2GPa MATERIAL CONTAINS BIAXIAL FORMABILITY EQUAL OR BETTER THAN THE 980MPa DP MATERIAL
MANUFACTURING CAPABILITY – FORMING
PART SHAPE & SPRING BACK

- After spring back
- Before spring back

980MPa DP

HE 1.2GPa
Welding strength is improved by 1) wider softened zone by increasing HAZ area and 2) Refining microstructure of nugget edge area.

**AFTER GRAIN REFINEMENT**

**BEFORE WELD TEMPER PULSE**

Reduce stress concentration of nugget by extending heat-affected zone (HAZ)

Cross Tensile Strength is Increased dramatically

<table>
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<th>Current condition</th>
<th>Optimized condition</th>
</tr>
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<tr>
<td>1.2GPa AHSS</td>
<td>980MPa DP</td>
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</tbody>
</table>

Current condition

Softened zone

Optimized condition

Softened zone
NISSAN 1.2GPa APPLICATIONS
TARGET PARTS/GRADERS TO APPLY
1.2 GPa MATERIAL

- Die Quench (1350MPa)
- 980MPa
- 780MPa
- 590MPa

BIW material mass ratio

Mild steel
NISSAN APPLIES NEW 1.2GPa MATERIAL TO Q50

1. FIRST APPLICATION OF 1.2GPa MATERIAL REDUCES MASS BY - 11 KG

2. NEXT STEP IS TO INCREASE APPLICATION OF AHSS

WORLD FIRST

Reinf. Ctr Pillar

Q50 6.0kg/Veh

-1.8kg/Veh

1.2GPa t1.2

440MPa t1.4

-0.6kg REINF-ROOF SIDE OTR, B

-1.5kg PLR-CTR INR

-0.8kg REINF-RAIL ROOF FR

-1.8kg REINF-CTR PLR

-1.0kg REINF-SILL CTR

-0.5kg REINF-ROOF SIDE OTR, A

-0.4kg REINF-SILL CTR

-11 KG MASS
INCREASE APPLICATION OF 1.2GPa

FUTURE APPLICATION

-15.9 kg
FUTURE DIRECTION
Increased Application of Advanced High Strength Steels Globally

**CURRENT AHSS RATIO:**

**FUTURE AHSS RATIO:**
FUTURE DIRECTION

Cost Reduction for Expanding Application
- Material
- Assembly

Cum. Weight Reduction
NEW 1.2GPa APPLICATION

Structural Integration
High Tensile Strength Steel
- BIW
- Chassis
- Forged Parts for P/T

Al & Mg
- Closure Panels
- Chassis
- P/T Parts etc.

Plastics
- FDR, Back Door etc.

Expand HTSS application

Structure  Steel  Light Metals & Plastics
NISSAN’S REQUEST TO STEEL CO.’S

PLEASE DEVELOP HE 1.2GPa FOR OEMS IN NORTH AMERICA
PRESENTATIONS WILL BE AVAILABLE MAY 16

Use your web-enabled device to download the presentations from today’s event

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