FREE PRESENTATION

WHY YOU CANNOT REGRADE EN 10025 JR MATERIAL to J2 MATERIAL:

The Metallurgy and the Consequences

LIVE OR ONLINE

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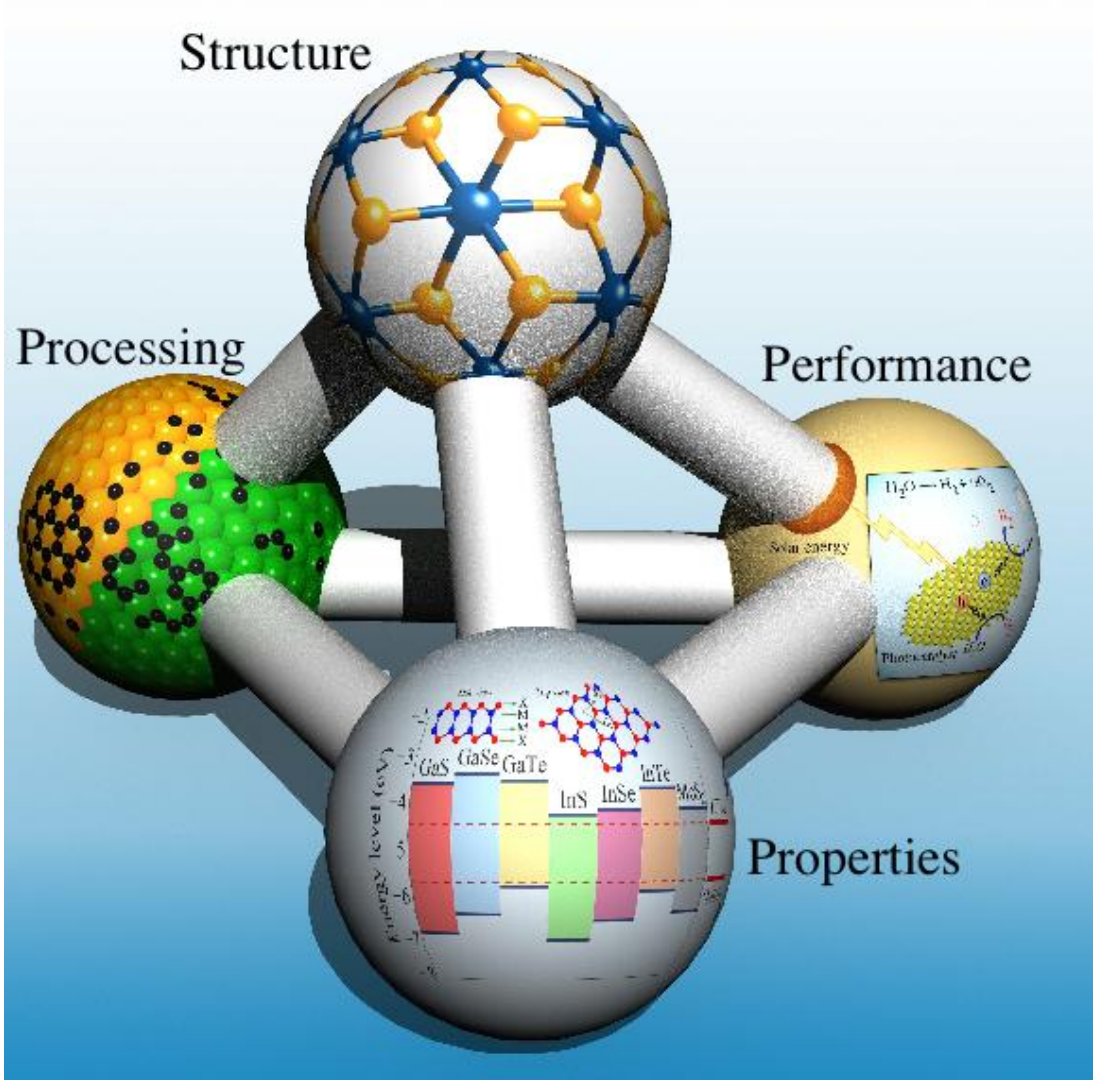
Jack and Rose could have lived happily ever after if the Titanic did not sink!

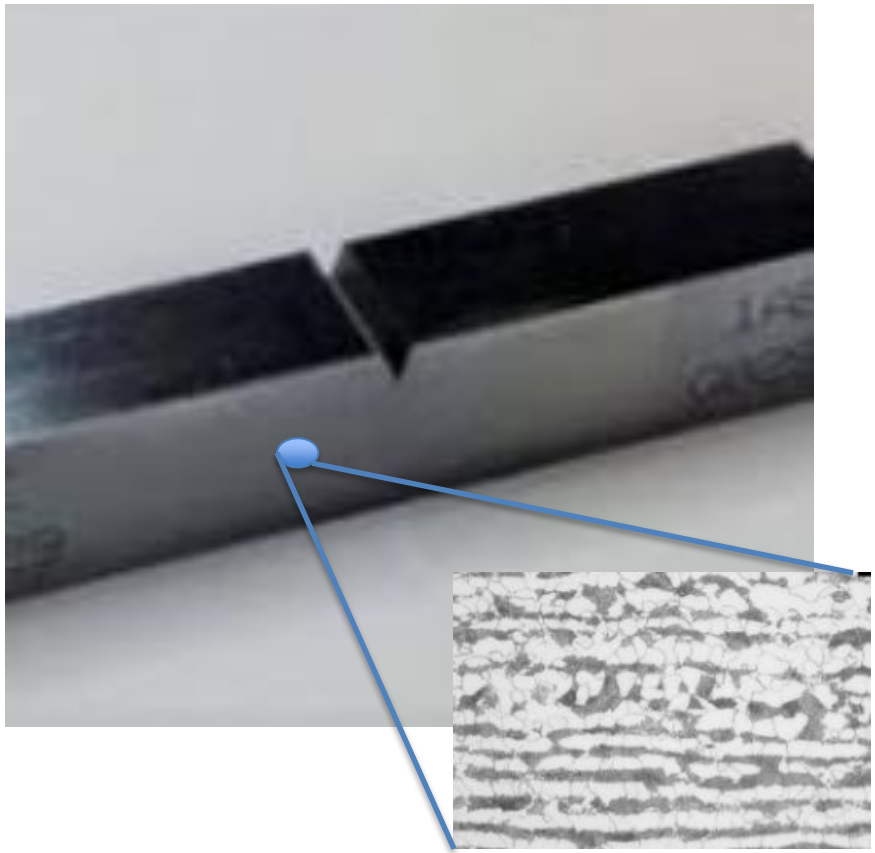
- https://www.youtube.com/watch?v=F2RnxZnubCM

What is metallurgy?

It is the **relationship** between **properties of materials**, directly related to how they are **processed** the **structure** that develops and their **performance**



What is the Charpy Impact Test – ASTM E23



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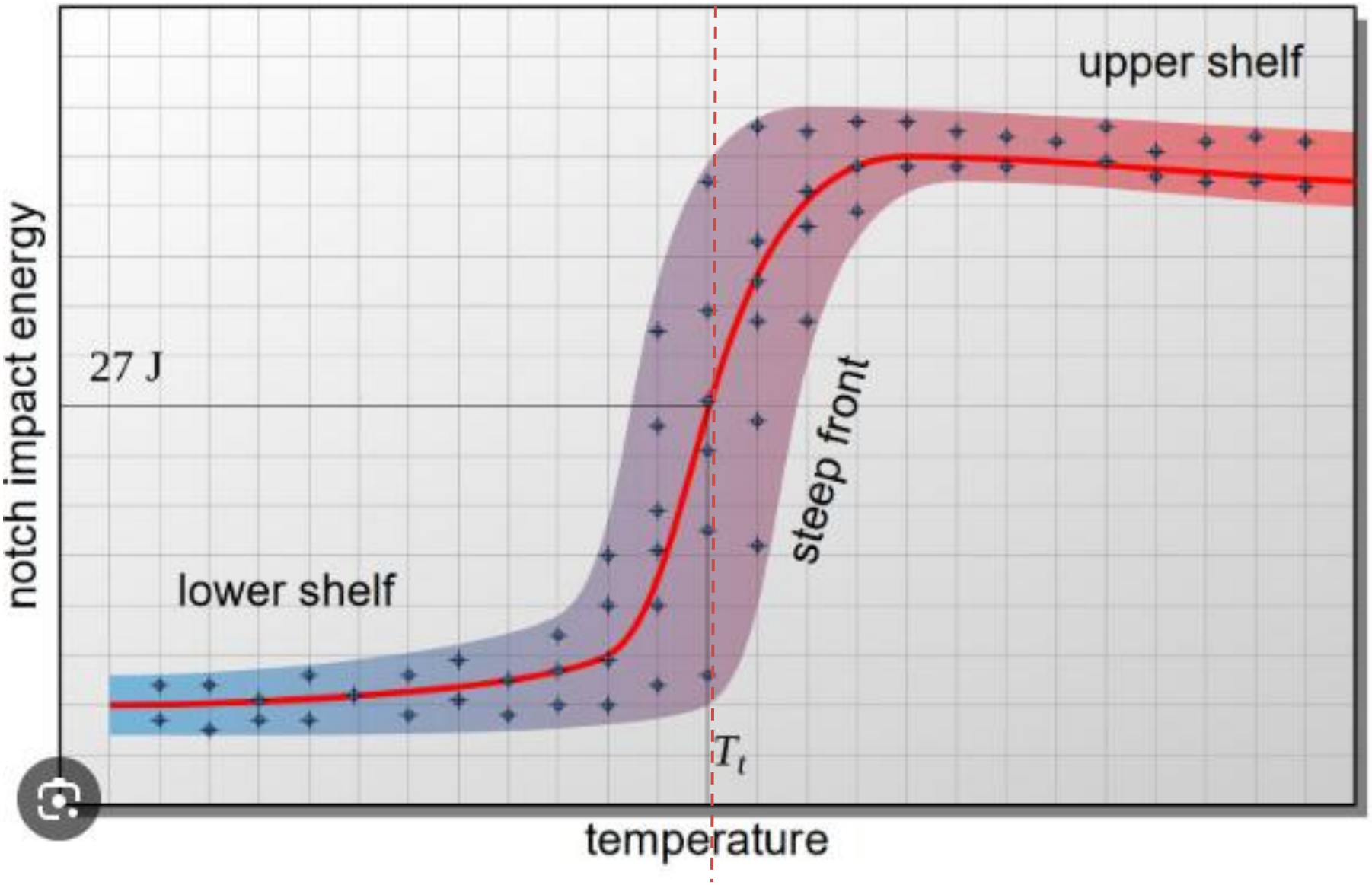
Charpy Shelf Energy/Temperature – Violent inflection point



Only steel behaves in this way, copper, aluminium and austenitic stainless steels do not

Introduction to EN 10025 JR and J2 designation

- **Why This Matters:**

- Structural steels like JR and J2 have different properties and applications.

- J2 material is specifically designed for low-temperature impact toughness.

- Some fabricators attempt to use JR material for J2 applications after passing a few impact tests

- **Objective:** Explain why this practice is unreliable and dangerous

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Key Differences Between JR and J2 Steels

- **Impact Toughness:** JR (27J at +20°C) vs J2 (27J at -20°C)

- **Deoxidation:** JR (Semi-killed or fully killed) vs J2 (Always fully killed)

- **Inclusions:** JR (More non-metallic inclusions) vs J2 (Lower inclusions, improves toughness)

Melting Process

- **Grain Structure:** JR (Coarser grain) vs J2 (Finer grain) & Crystallographic Texture JR different to J2

- **Consistency:** JR (Variable impact toughness) vs J2 (Designed for consistent low-temperature performance)

Hot Rolling Process

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- Significant change in Mechanical Properties – Charpy Shelf Temperature
- Result of the Steel Making Process

EN 10025 J2	EN 10025 JR
Deoxidation process is fully killed	**Deoxidation** process is either semi killed
Tighter restrictions on inclusion content	Less restrictions on inclusion content
Hot rolling schedule controlled to achieve fine grain structure & randon texture	**Hot rolling schedule** not as controlled resulting in a coarse grain structure defined texture

Lets Break It Down

MELTING

HOT ROLLING

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MELTING

Understanding Fully Killed vs. Semi-Killed Steel

Deoxidation in Steelmaking & Its Impact on Steel Grades (JR vs. J2)

What is Deoxidation during Melting ?

- Deoxidation is the process of **removing oxygen from molten steel** to prevent **oxide formation**.
- Oxygen can lead to **defects**, reducing steel strength, **toughness**, and weldability.
- Methods:
  - Use of deoxidizers (Al, Si, Mn, Ca)
  - Vacuum treatment – rimmed steels
  - Slag control

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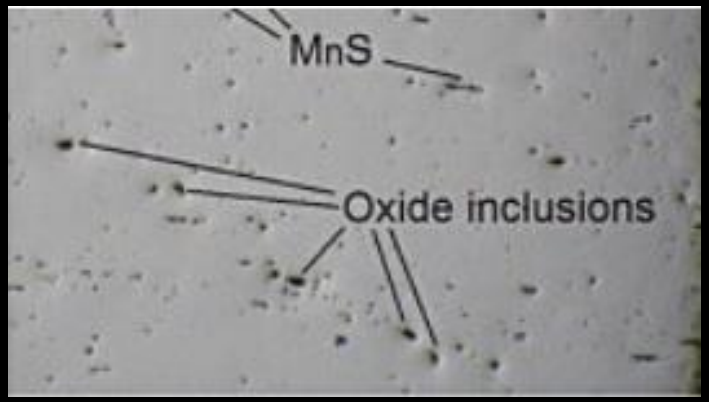
What is the difference between Fully Killed and Semi Killed Steel ?

- **Fully Killed Steel**
  - Steel that has been completely deoxidized before casting
  - Using Al, Si and Ca
  - Key to produce J2 and EH36
- **Semi Killed Steel**
  - Steel that has been partially oxidized before casting
  - Some oxygen remains in the melt
  - Inclusions are present and oxygen exists in solid solution



Oxide Inclusions

Destroy Impact Toughness lowering Charpy Impact Energy Joules and increasing shelf temperature

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Melting

JR and J2 are not the same material since they are not given the same **deoxidation treatment** during casting

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Introduction to Hot Rolling

Process of taking a continuously cast slab and **systemically reducing its thickness** step by step to create thin strip or plate

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https://www.youtube.com/watch?v=5Pu1YkWg7Ys

Process Flow of Hot Rolling

1. Reheating - Steel slabs heated in a furnace if not continually cast
2. Rough Rolling - Initial size reduction
3. Finishing Rolling - Final thickness and shape
4. Controlled Cooling - Air cooling or accelerated cooling
5. Cutting & Inspection - Size cutting and quality control

Key Hot Rolling Control Parameters

- **Roughing Temperature**
- **Finish Rolling Temperature** (FRT): J2 finishes at lower FRT (~800°C) for **better impact strength**.

- **Speed of the process**, reduction in thickness during each pass. **JR faster process than J2.**

- **Cooling Rate**: J2 may use accelerated cooling to **refined grains and more random texture**

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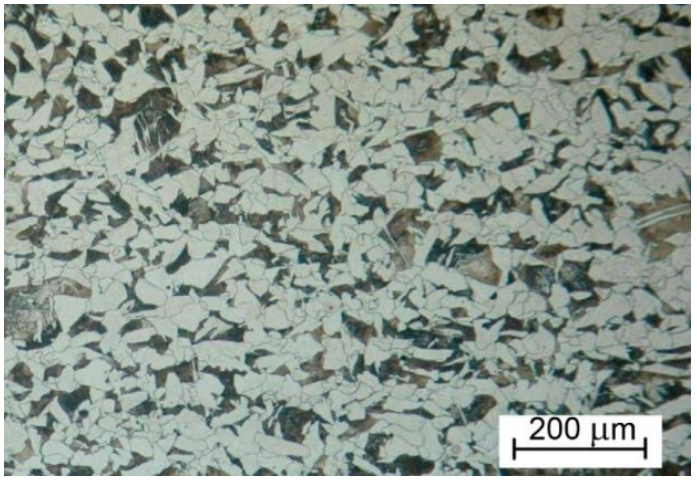
Microstructure & Mechanical Property Comparison

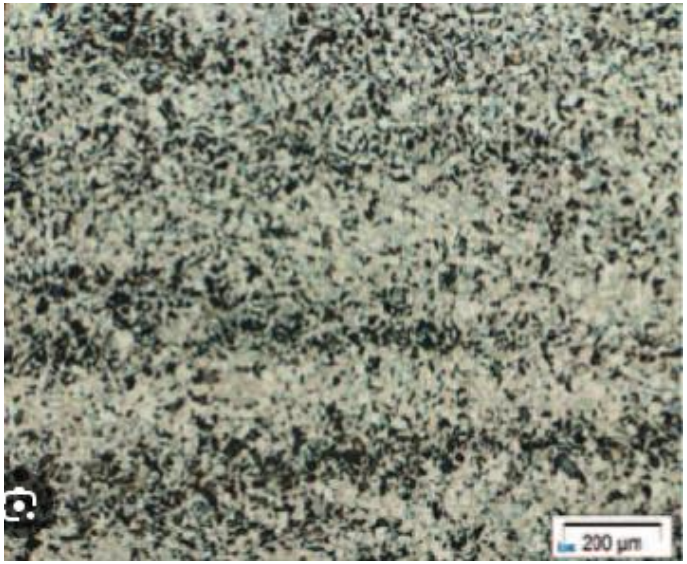
- JR: **Coarser grain** structure, lower toughness.

- J2: **Fine-grained** microstructure, better impact resistance.

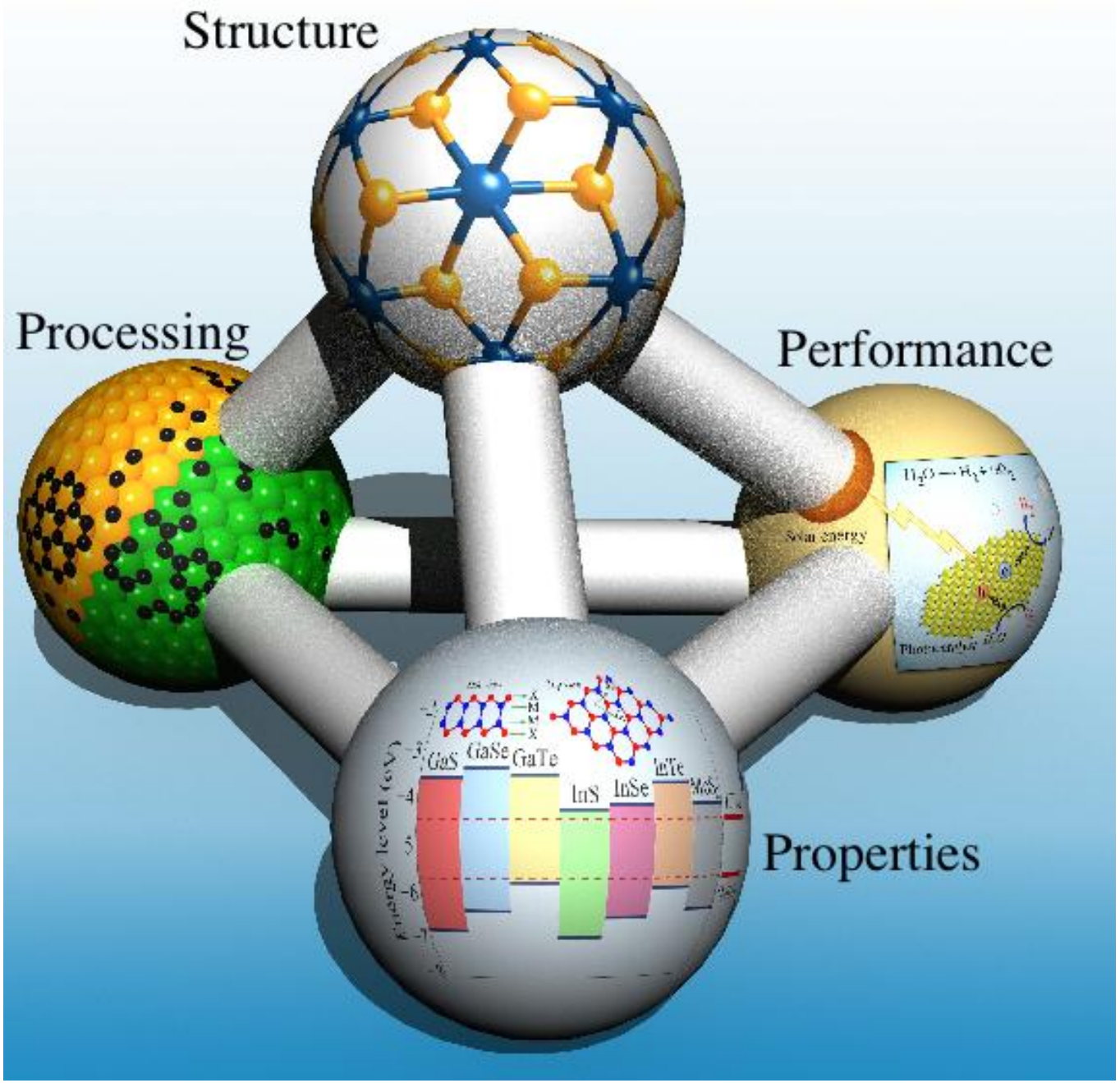
But this is what you can see with a light microscope
There is much more

JR Material

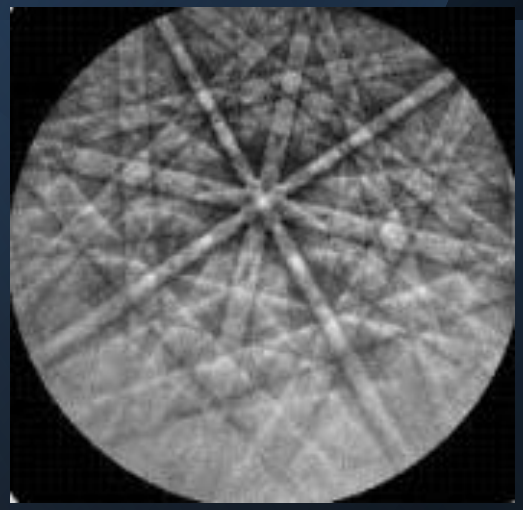




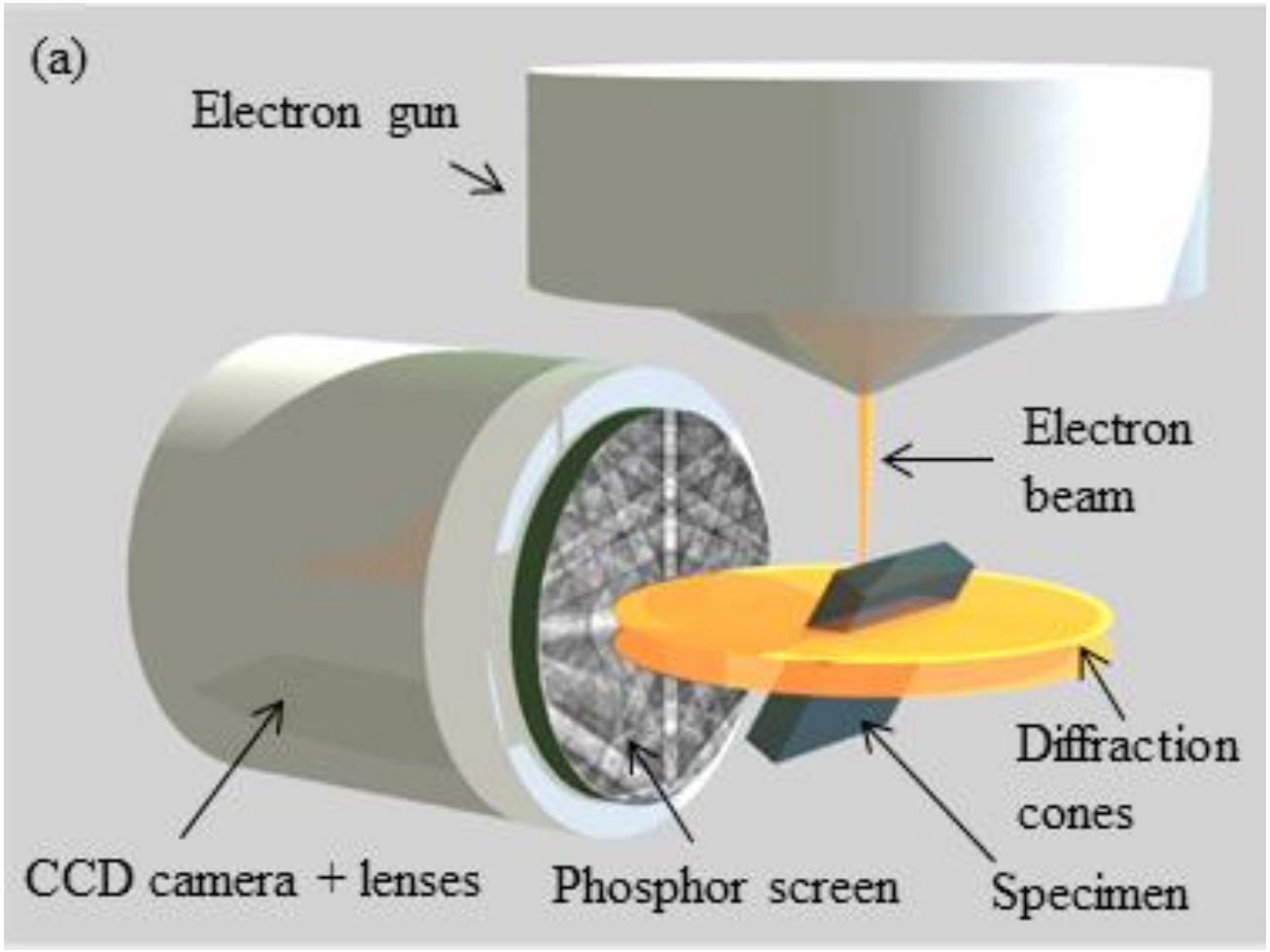
J2 Material


Structure
Processing
Performance
Properties
Solar energy
GaS
GaSe
GaTe
InS
InSe
Energy level (eV)

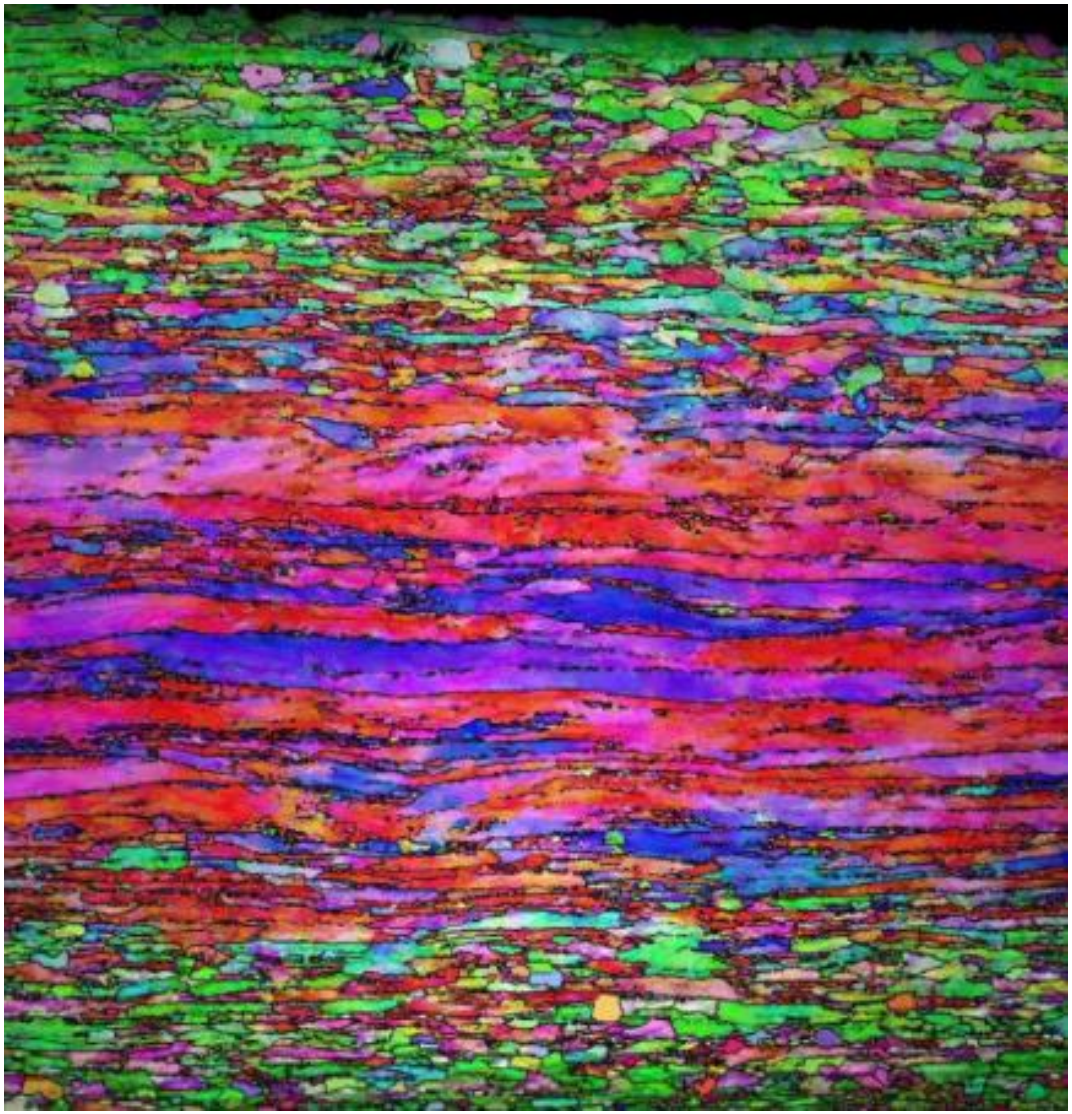
Lets go a bit deeper!



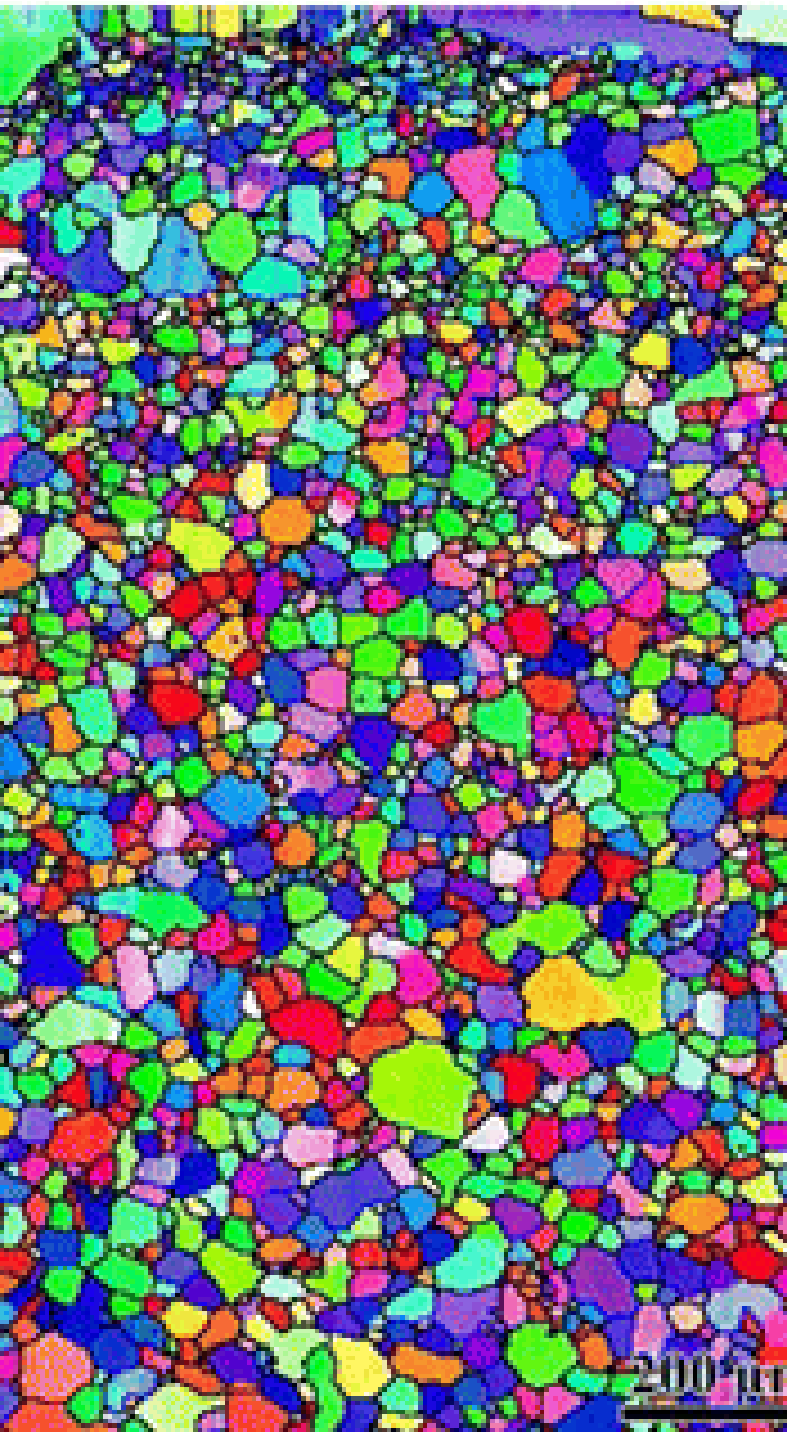
- Crystallographic Texture Development
  - Formation of preferred orientation of grains during hot rolling
  - **J2 material is controlled** so that the texture development is **more random** – reduces Charpy shelf temperature
  - **JR material is subject to less controls** which leads to a more **defined texture** – increases Charpy shelf temperature



Crystallographic Texture Measurement



Crystallographic Texture Measurement
Preferred Orientation



Crystallographic Texture Measurement

Random Orientation

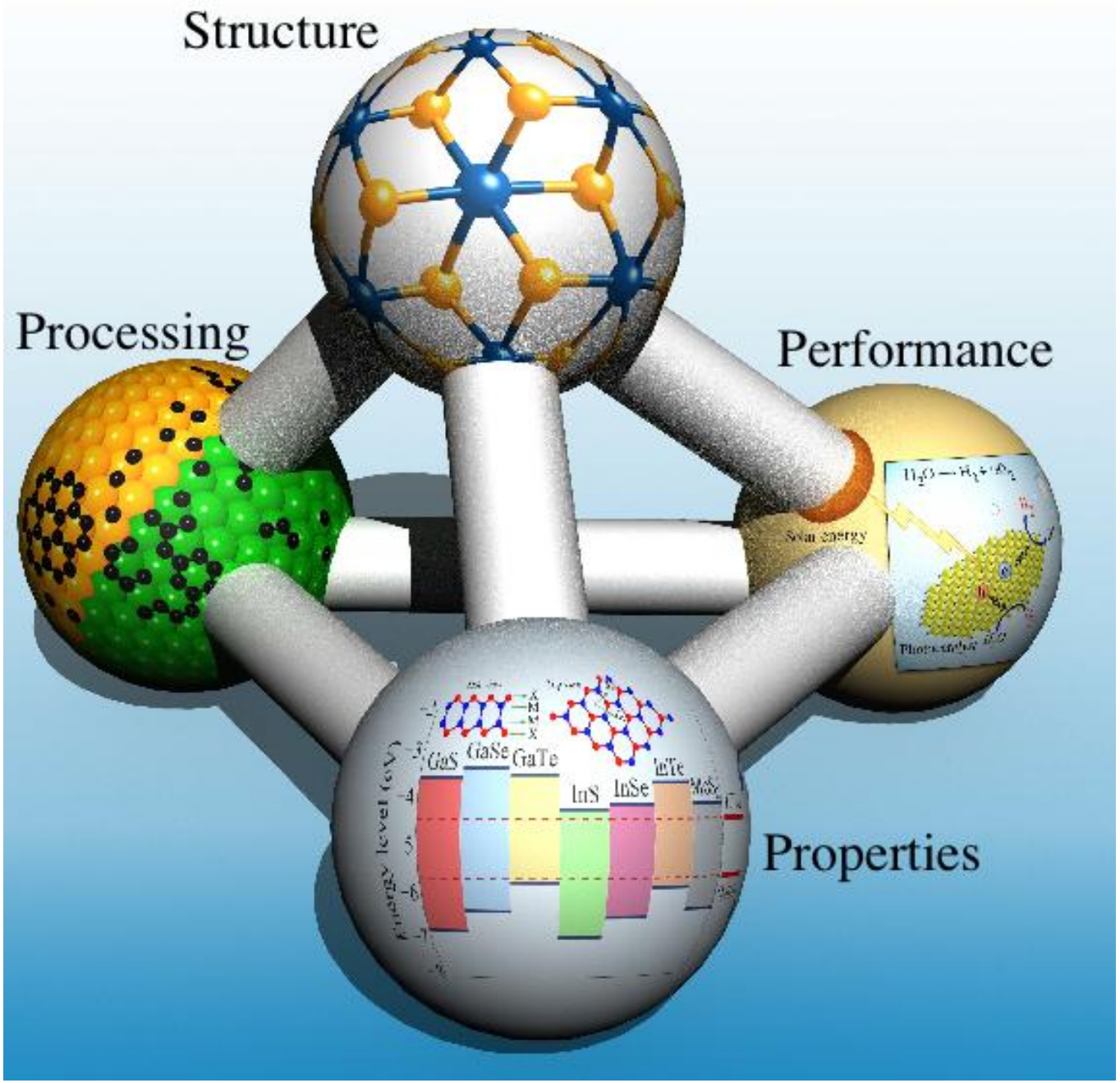
Summary Parameters

EN 10025 JR Material

- Hot rolled above the recrystallisation temperature
- Finishing at relatively high temperature - 900C
- Results in coarser grain structure
- Preferred crystallographic orientation

EN 10025 J2 Material

- Hot rolled at lower temperatures -900C
- Results in strain accumulation – longer process times
- Results in finer ferrite pearlite grain structure (almost half JR)
- Random crystallographic orientation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Summary

- EN 10025 JR Material is a totally different Material to EN 10025 J2 and EH 36.

- Key differences in **Melting Procedure**
- Key differences in **Hot Rolling Schedule**

Process-Structure-Properties-Performance

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- JR cannot reliably deliver Charpy V notch Energy at -20C

- J2 is designed to reliably delivery Charpy V notch Energy at -20C

Application-Based Selection

- - S355JR: **General structural** applications (buildings, bridges, beams)
- - S355J2: **Low-temperature** environments, **offshore structures**, **subsea fabrication** heavy machinery.

Deep Water Horizon

Record-setting penalties: BP paid the **largest environmental criminal fine** in U.S. history at that time ($4 billion) and the **largest civil environmental settlement ever** ($20.8 billion).