

Why You Cannot Regrade EN 10025 JR Material to J2 Material With Charpy Impact Testing

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[Watch Webinar Recording Here](#)

Dr Janet Cotton PR.Eng

Managing Director & Founder:
One Eighty
Materials Engineering Solutions



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- For the Engineering Institute of Technology (EIT) visit: <https://www.eit.edu.au/>
- For the Engineering College of Technology (ECT) visit: <https://www.ect.ac.uk/>
- For the Engineering College of Science and Technology (ECST) visit: <https://www.ecst.ac.za/>

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Introduction – Presenter

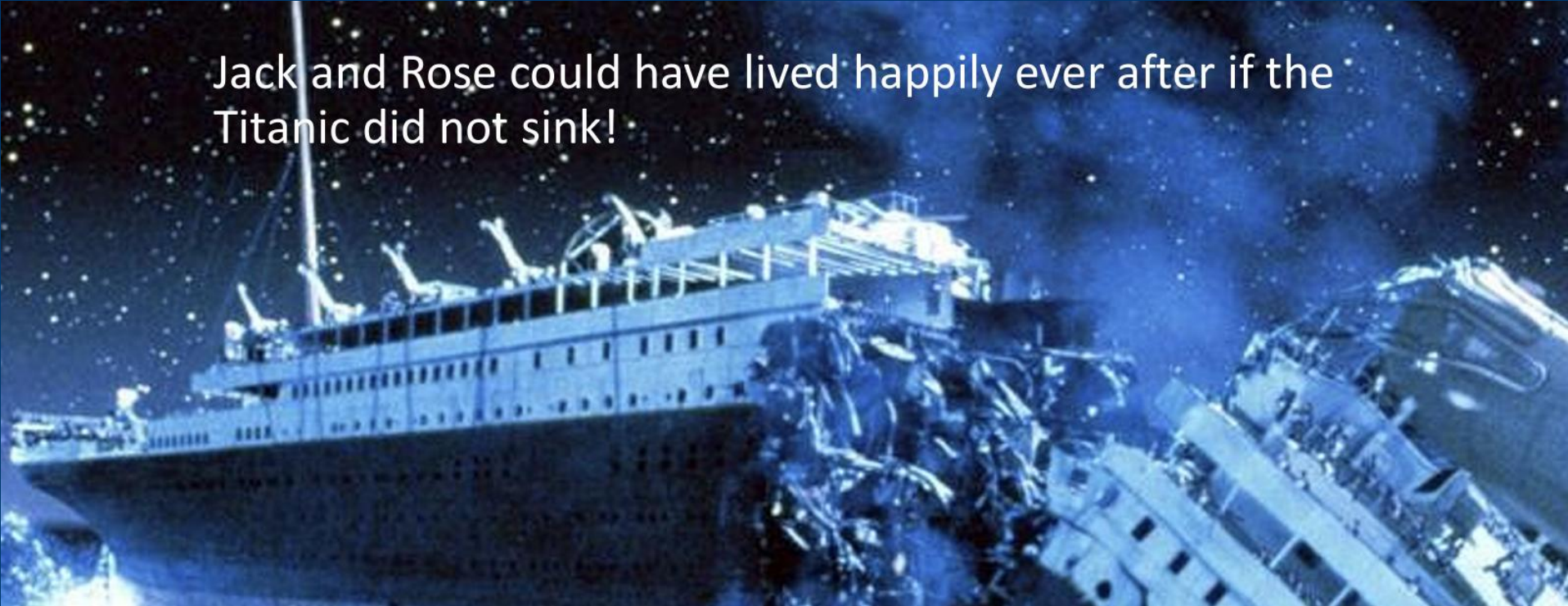
Dr Janet Cotton

From the moment she launched One Eighty Materials Engineering Solutions at just 28 years old, Dr Janet Cotton has been rewriting the rules of engineering in Africa. What began as a bold idea to bring engineering rigor to real-world problems has grown into Africa's most widely scoped ISO 17025:2017-accredited materials and metallurgical testing laboratory, a technical powerhouse trusted by industries across the continent and around the globe.

Janet is more than a founder; she is a pioneer of industrial resilience and forensic engineering. Under her leadership, One Eighty has become the go-to name for solving the toughest engineering challenges, from catastrophic component failures to complex materials selection problems, helping businesses protect infrastructure, save costs and de-risk major capital projects.



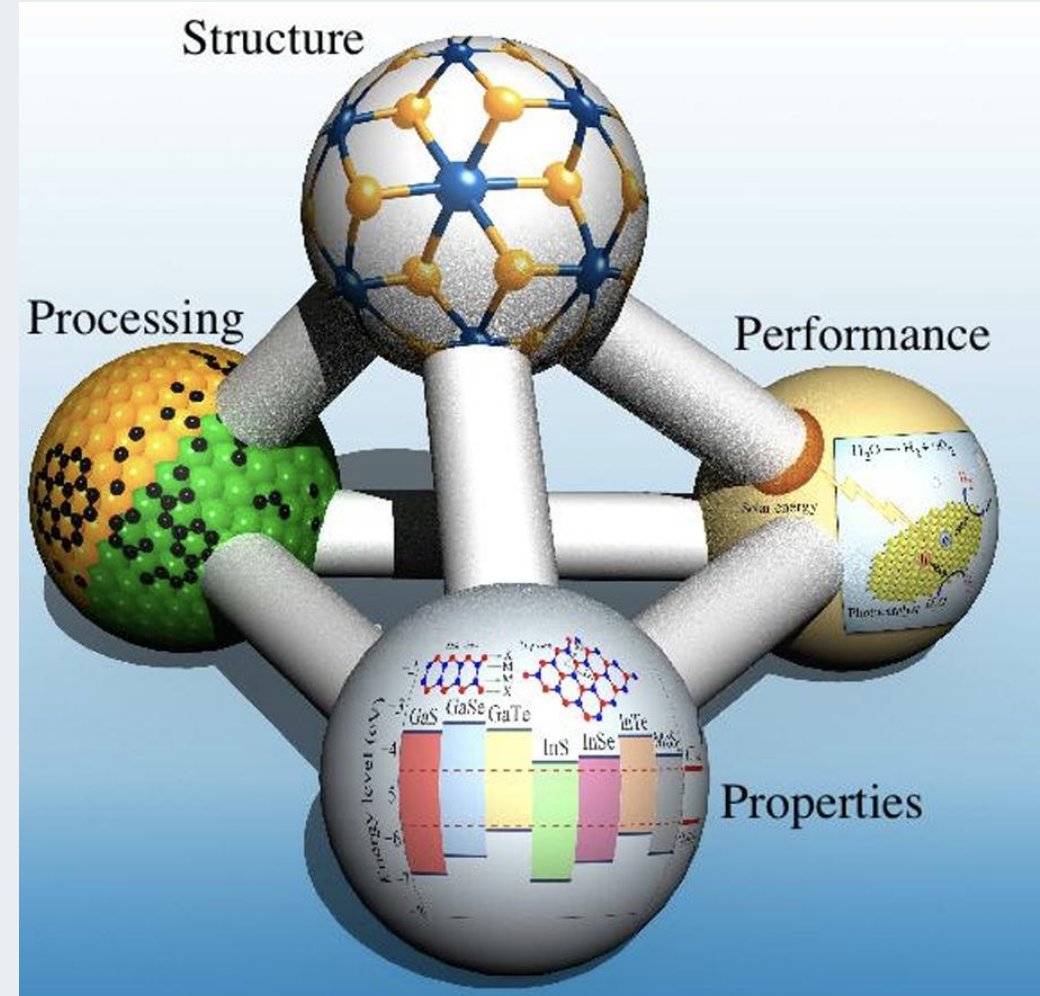
Jack and Rose could have lived happily ever after if the Titanic did not sink!



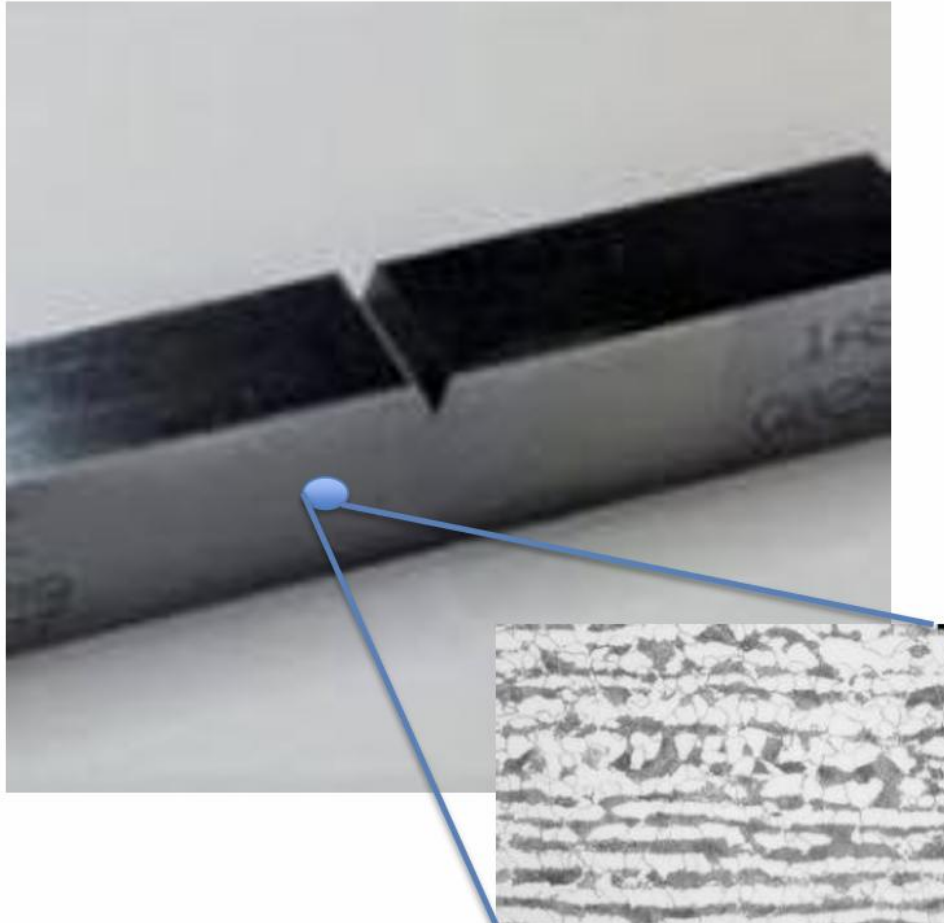
<https://www.youtube.com/watch?v=F2RnxZnubCM>

What is metallurgy?

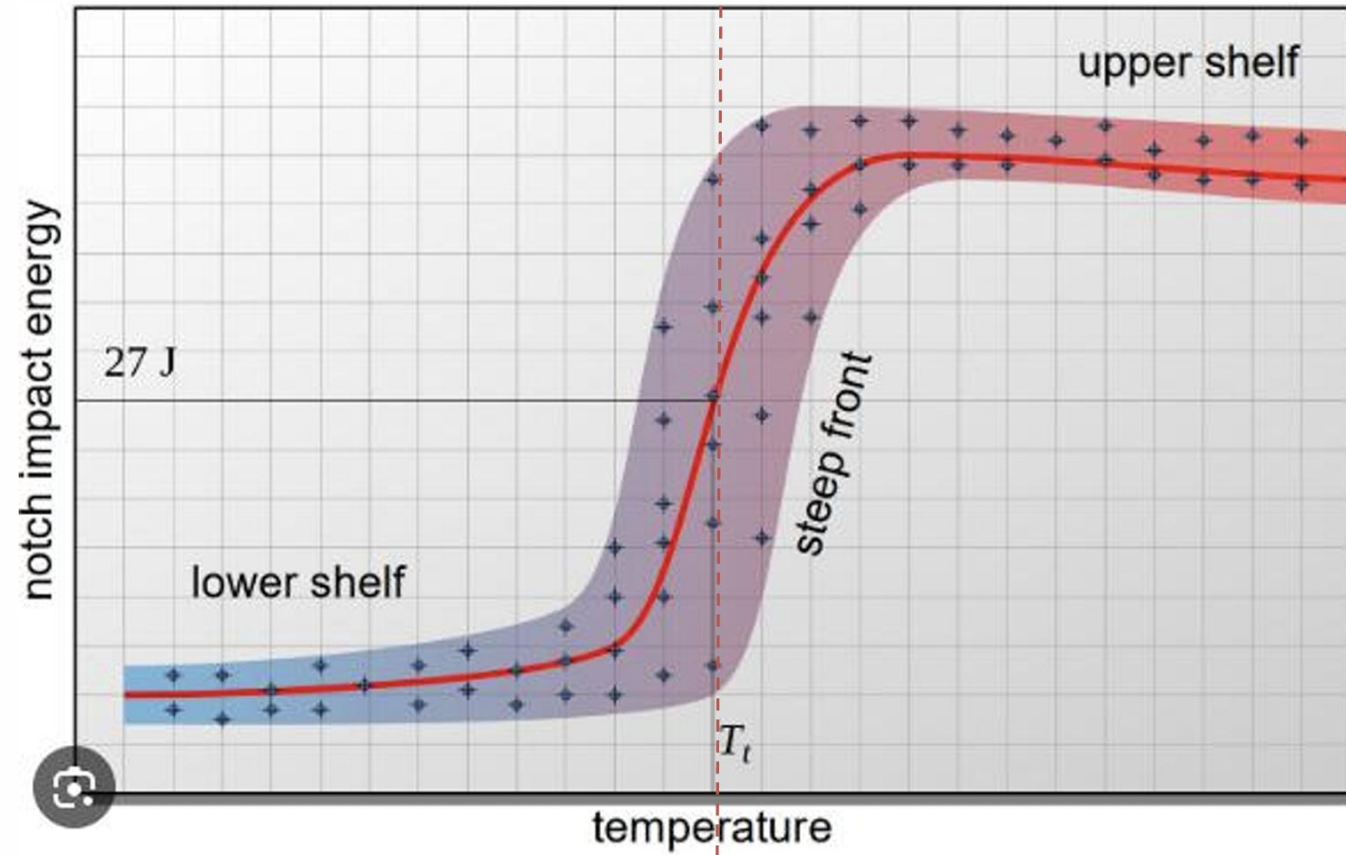
It is the relationship between properties of materials, directly related to how they are processed the structure that develops and their performance



What is the Charpy Impact Test – ASTM E23



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

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)

- ****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)

Melting Process

Hot Rolling Process

Lets Break It Down

Melting Hot Rolling

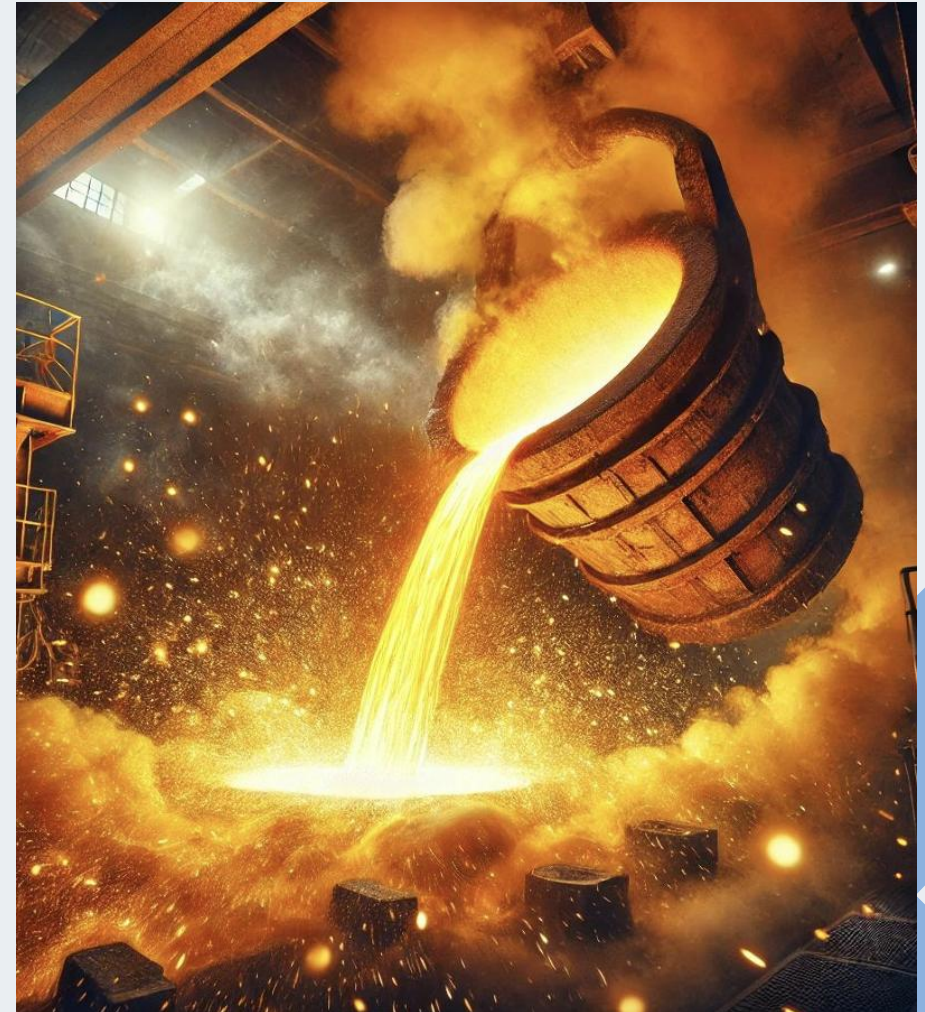
- Significant change in Mechanical Properties – Charpy Shelf Temperature
- Result of the Steel Making Process

EN 10025 J2	EN 10025 JRN 10025 JR
Deoxidation process is fully killed	Deoxidation process I 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

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



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

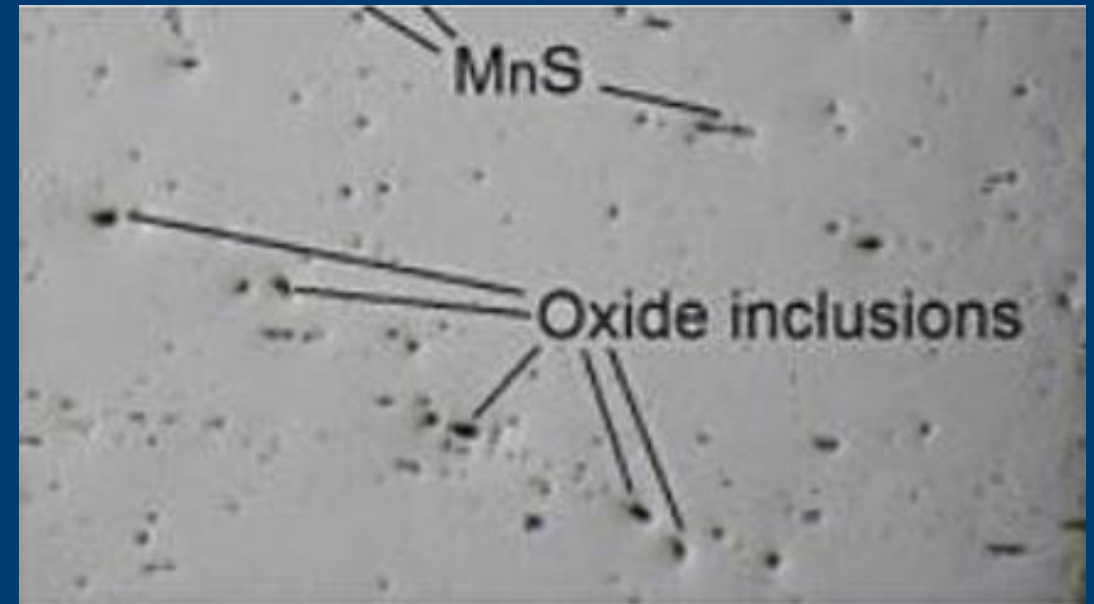


- **Fully Killed Steel**
 - Steel that has been completely deoxidized before casting
 - Using Al, Si and Ca
 - Key to produce J2 and EH36
- **Semi Killed Steel**
 - Steel that has been partially oxidized before casting
 - Some oxygen remains in the melt
 - Inclusions are present and oxygen exists in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



Oxide Inclusions

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



Melting



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

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

<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

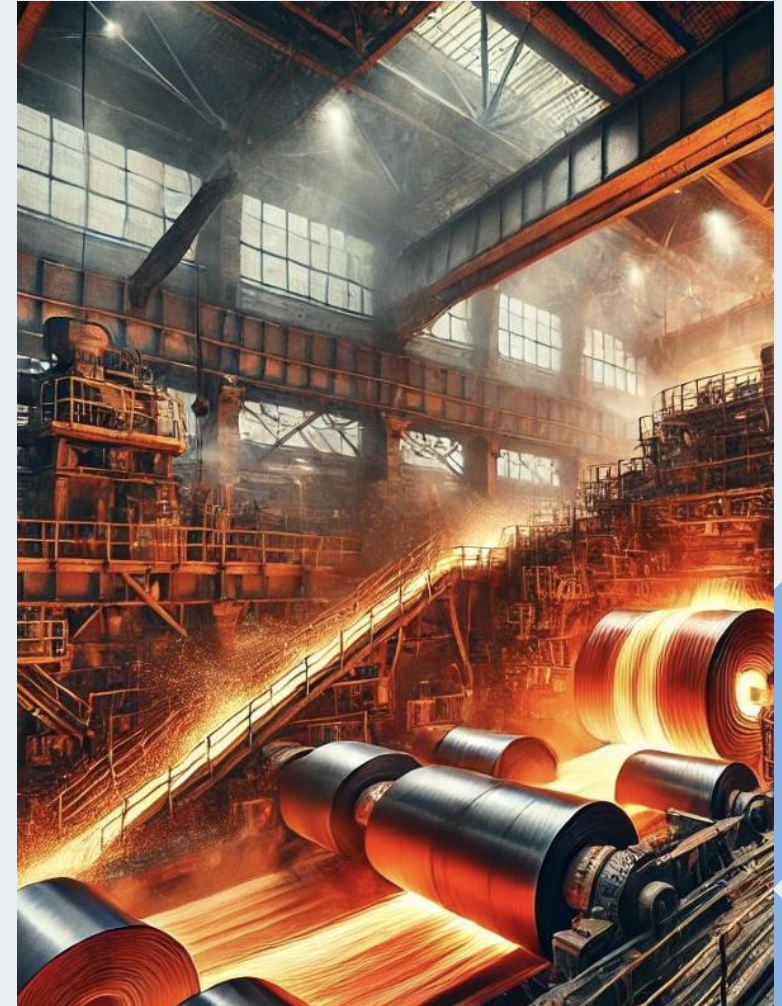
3. Finishing Rolling - Final thickness and shape

4. Controlled Cooling - Air cooling or accelerated cooling

5. Cutting & Inspection - Size cutting and quality control

Key Hot Rolling Control Parameters

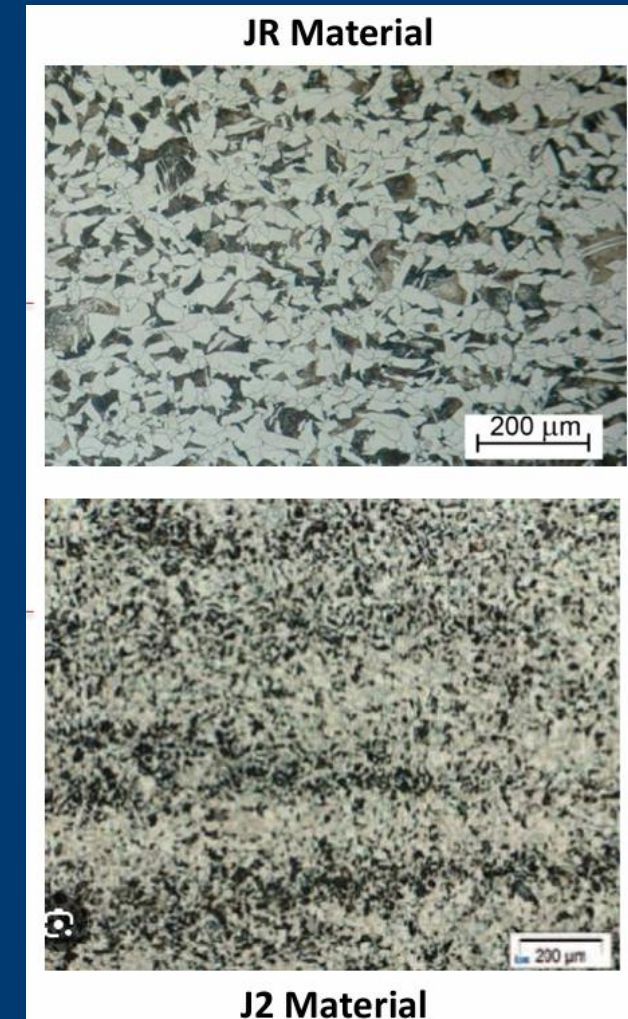
- Roughing Temperature
- Finish Rolling Temperature (FRT): J2 finishes at lower FRT ($\sim 800^{\circ}\text{C}$) for **better impact strength**.
- Speed of the process, reduction in thickness during each pass. JR **faster process than J2**.
- Cooling Rate: J2 may use accelerated cooling to **refined grains and more random texture**

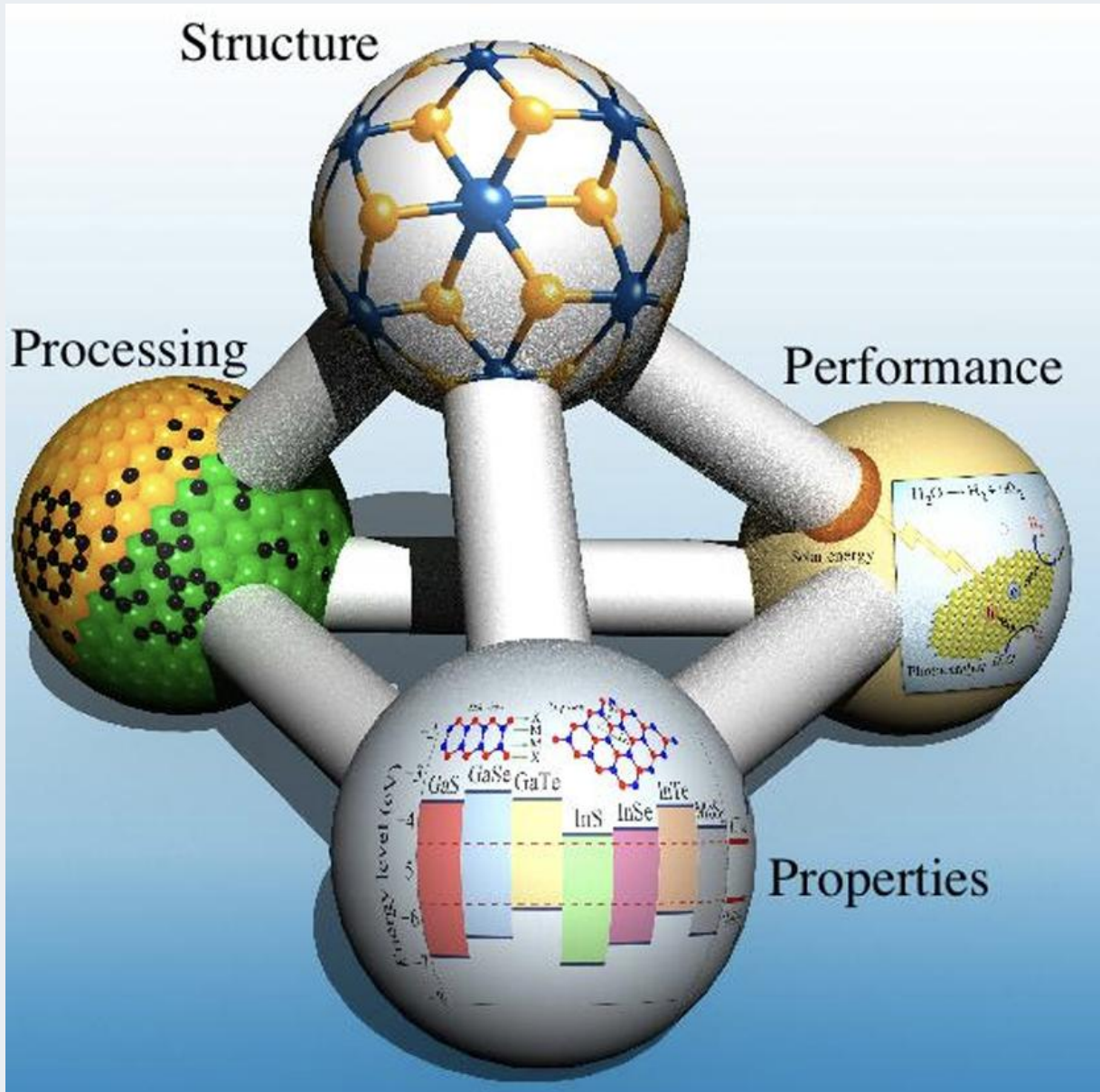


Microstructure & Mechanical Property Comparison

- 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

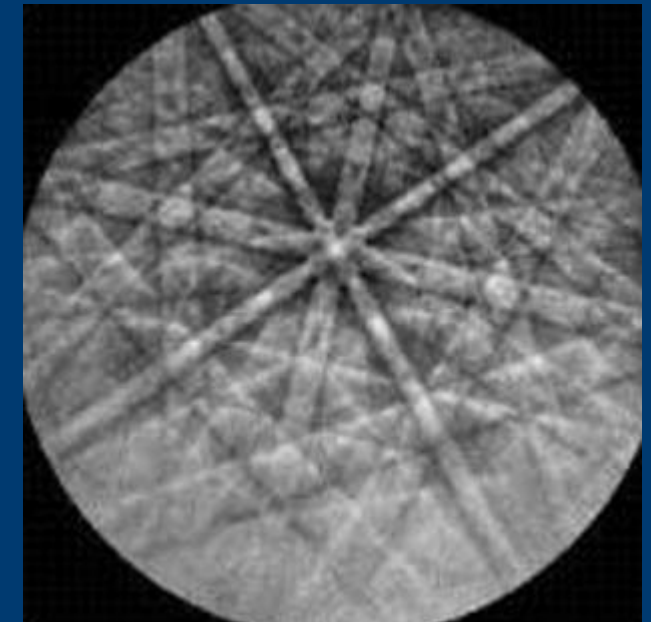




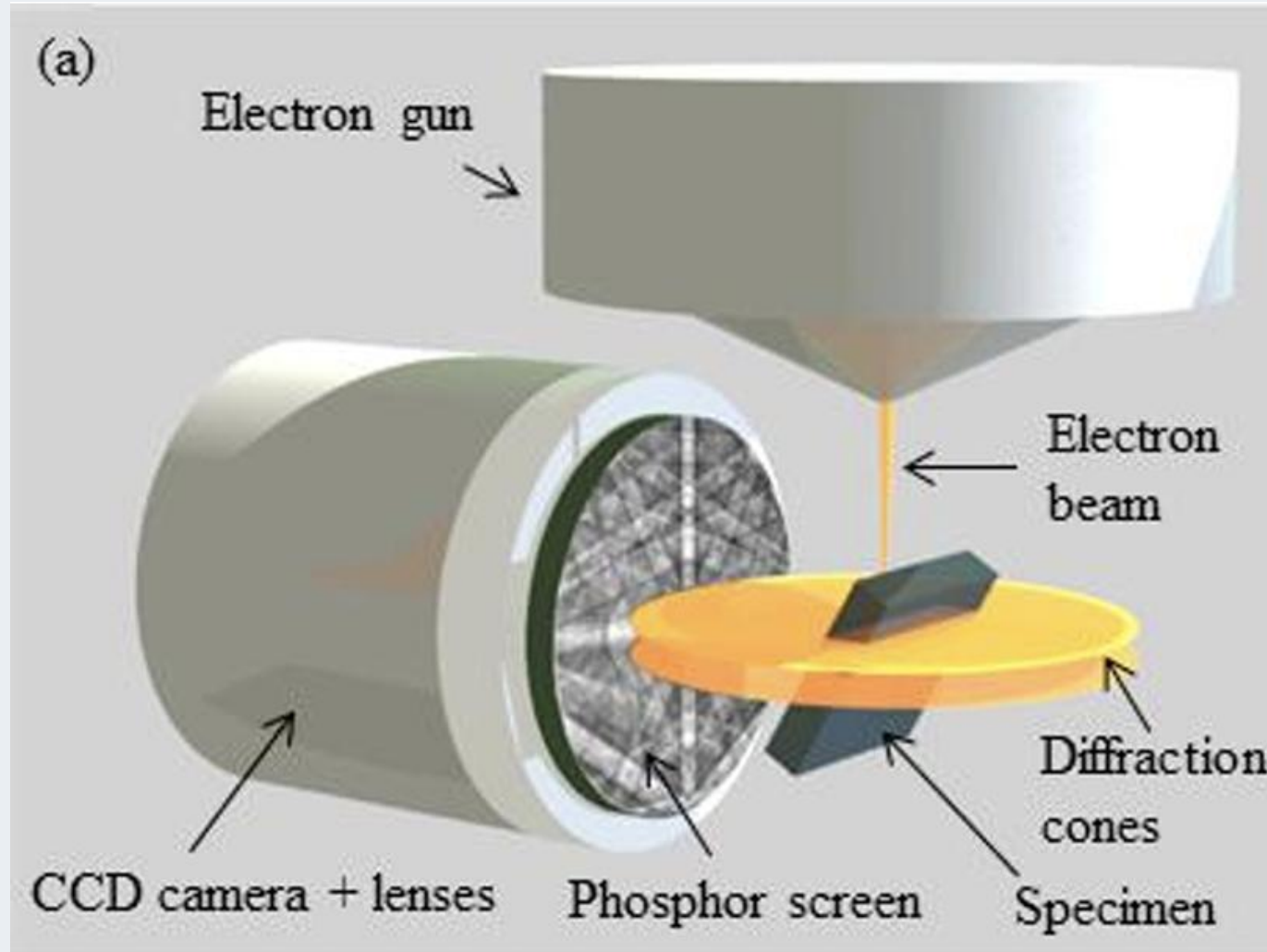
Let's go a bit deeper!

- **Crystallographic Texture Development**

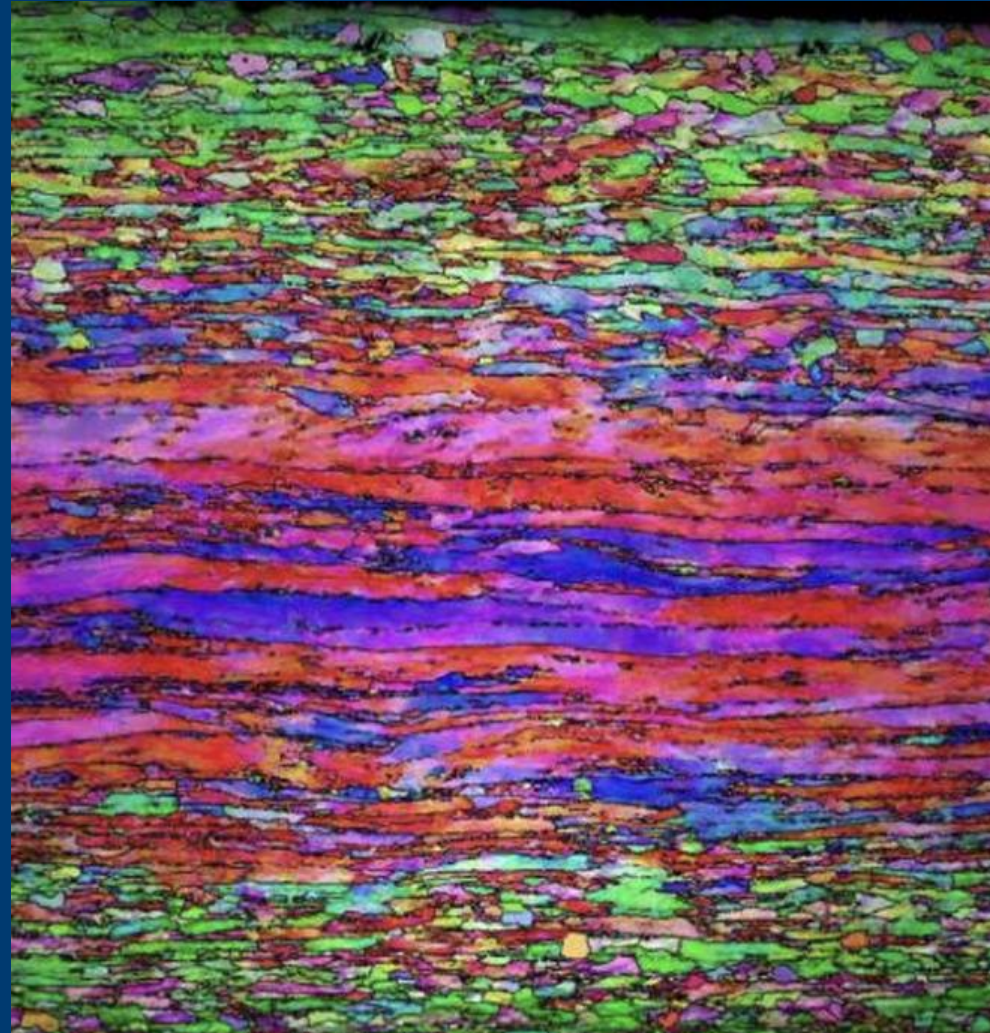
- Formation of preferred orientation of grains during hot rolling
- **J2 material is controlled** so that the texture development is **more random**
- reduces Charpy shelf temperature
- **JR material is subject to less controls** which leads to a more **defined texture** - increases Charpy shelf temperature



Crystallographic Texture Measurement



Crystallographic Texture Measurement Preferred Orientation





Crystallographic Texture Measurement Random Orientation

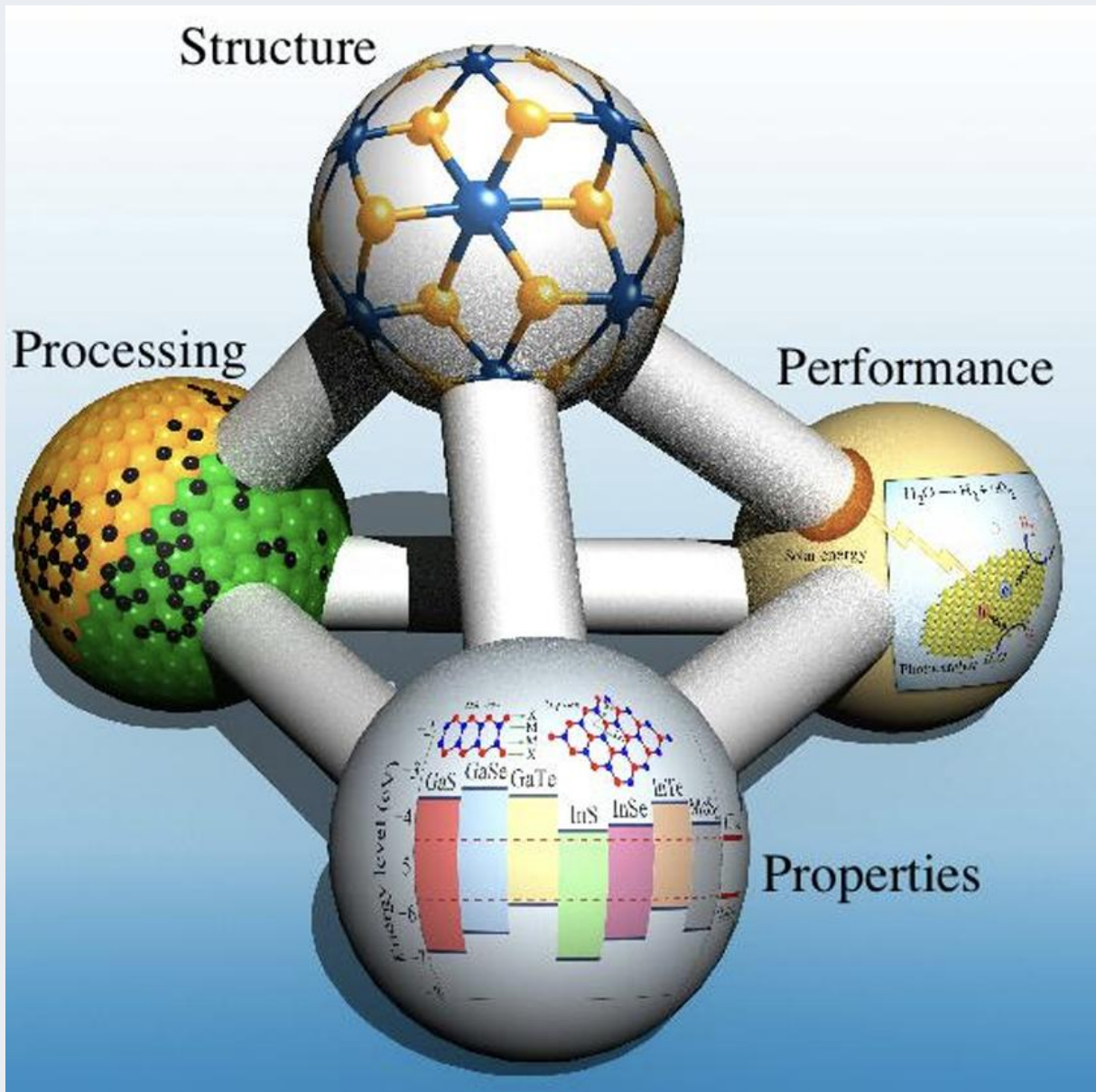
Summary Parameters

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



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

- 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).

Thank You!

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Please note: courses listed below are subject to their own regulatory requirements—refer to the relevant website for further information.

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52932WA Advanced Diploma of Plant Engineering		4 August 2026
Professional Certificate of Competency in Mechanical Engineering		11 August 2026
Professional Certificate of Competency in the Fundamentals of Process Plant Layout & Piping Design		11 August 2026
Professional Certificate of Competency in Onshore and Offshore Pipeline Systems		8 September 2026
Professional Certificate of Competency in Heating, Ventilation and Air-Conditioning (HVAC)		8 September 2026
Graduate Certificate in Mechanical Engineering		4 January 2027
Graduate Diploma of Engineering (Mechanical)		4 January 2027
Online - Bachelor of Science (Mechanical Engineering)		8 February 2026
Master of Engineering (Mechanical)		4 January 2027
Master of Engineering - Applied Research (Mechanical)		4 January 2027
Bachelor of Science (Mechanical Engineering)		8 February 2027

Upcoming Courses



Please note: courses listed below are offered by separate institutions in the UK and South Africa, each subject to their own regulatory requirements - refer to the relevant website for location-specific details.

Engineering College of Technology (ECT) <i>UK qualifications</i>		Start Date
Bachelor of Engineering (Honours) in Industrial Automation		21 September 2026
Bachelor of Engineering (Honours) in Electrical Engineering		21 September 2026
Master of Science (Power System Analysis and Renewable Integration)		5 October 2026
Master of Science (Industrial Automation and Instrumentation Control)		5 October 2026

Engineering College of Science and Technology (ECST) <i>South African accredited qualification & ECSA-endorsed</i>		Start Date
Bachelor of Engineering Technology in Electrical Engineering		3 August 2026

Q&A



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