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# The Materials Age

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# The Stone age: 3.4 million BC – 2000 BC

1.9 million BC
Olduvai Gorge, Tanzania

1.2 million BC
Olduvai Gorge, Tanzania

# The Bronze age: 2000 BC – 1000 BC

1400 BC
France

1200 BC
Britain

# The Iron age: 1000 BC – 500 AD

900 BC
Iran

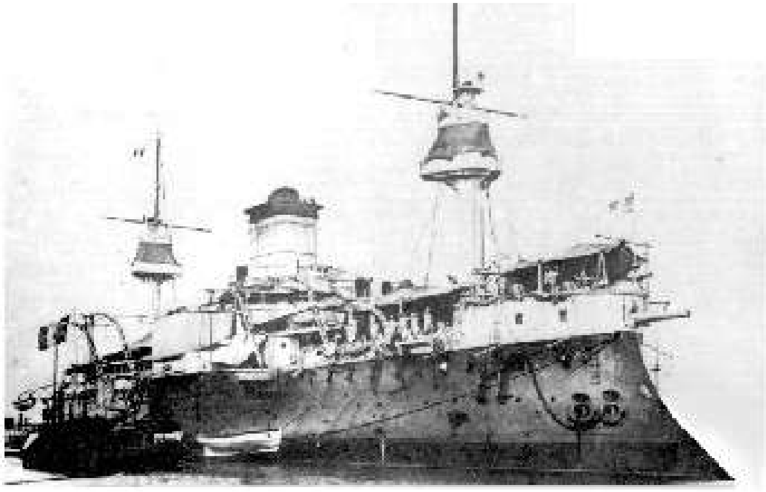
300 BC
Yorkshire

# First Steel age: 500 AD – 1850 AD

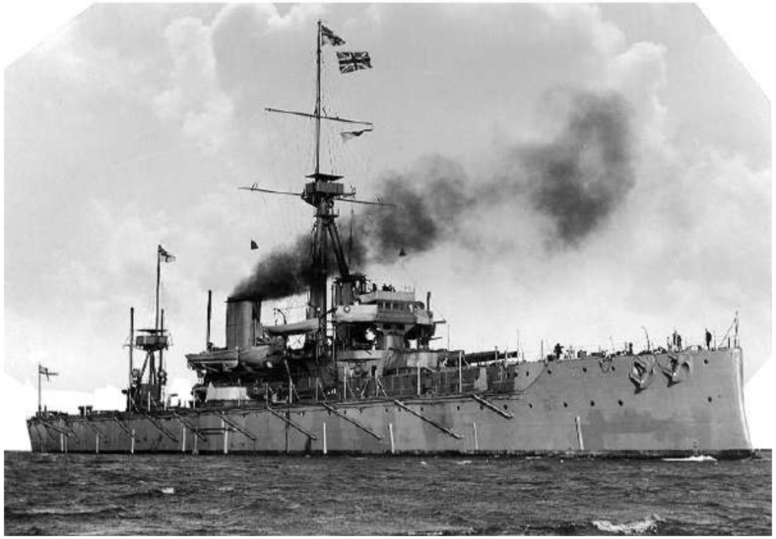
**900 AD**
**Oxford**

**1200 AD**
**Damascus**

# Second Steel age: 1850 AD – 1930 AD



**1876**
**France**



**1906**
**Portsmouth**

# Modern materials: plastics

# Modern materials: ceramics

# Modern materials: composites

# Modern materials: rubbers

- Potential energy in elastic band: $$E = \frac{1}{2}kx^2 = \frac{1}{2}Fx = \frac{1}{2}10 \times 0.1 = 0.5\,\mathrm{J}$$

# Modern materials: rubbers

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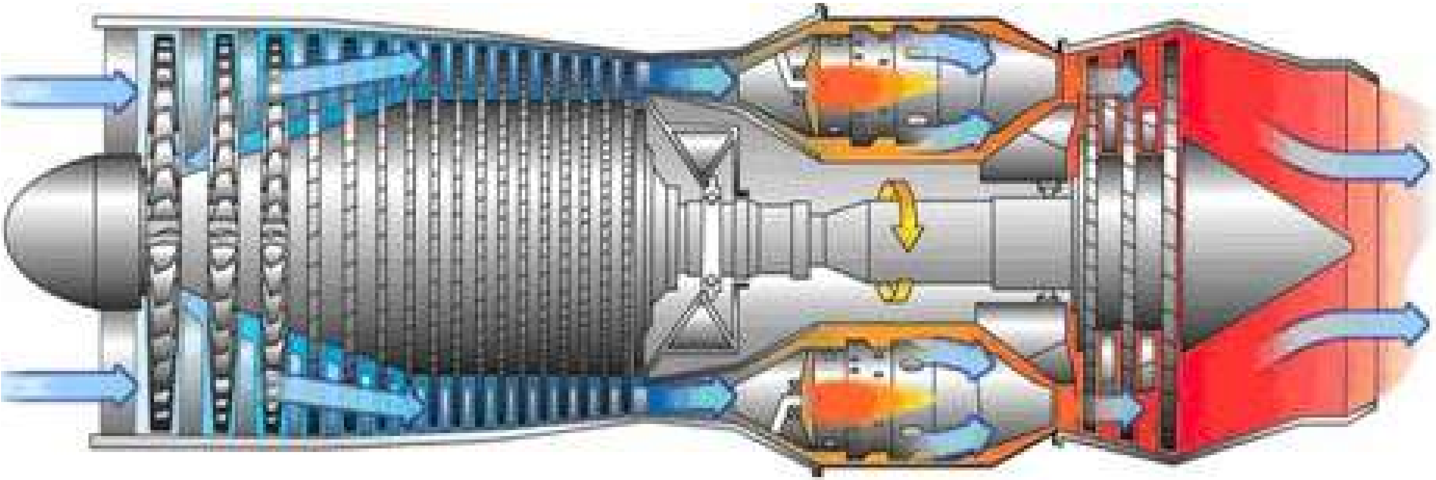
- Kinetic energy in handgun bullet: $$E = \frac{1}{2}mv^2 = \frac{1}{2}0.005 \times 300^2 = 225\,\mathrm{J}$$

# Modern materials: rubbers

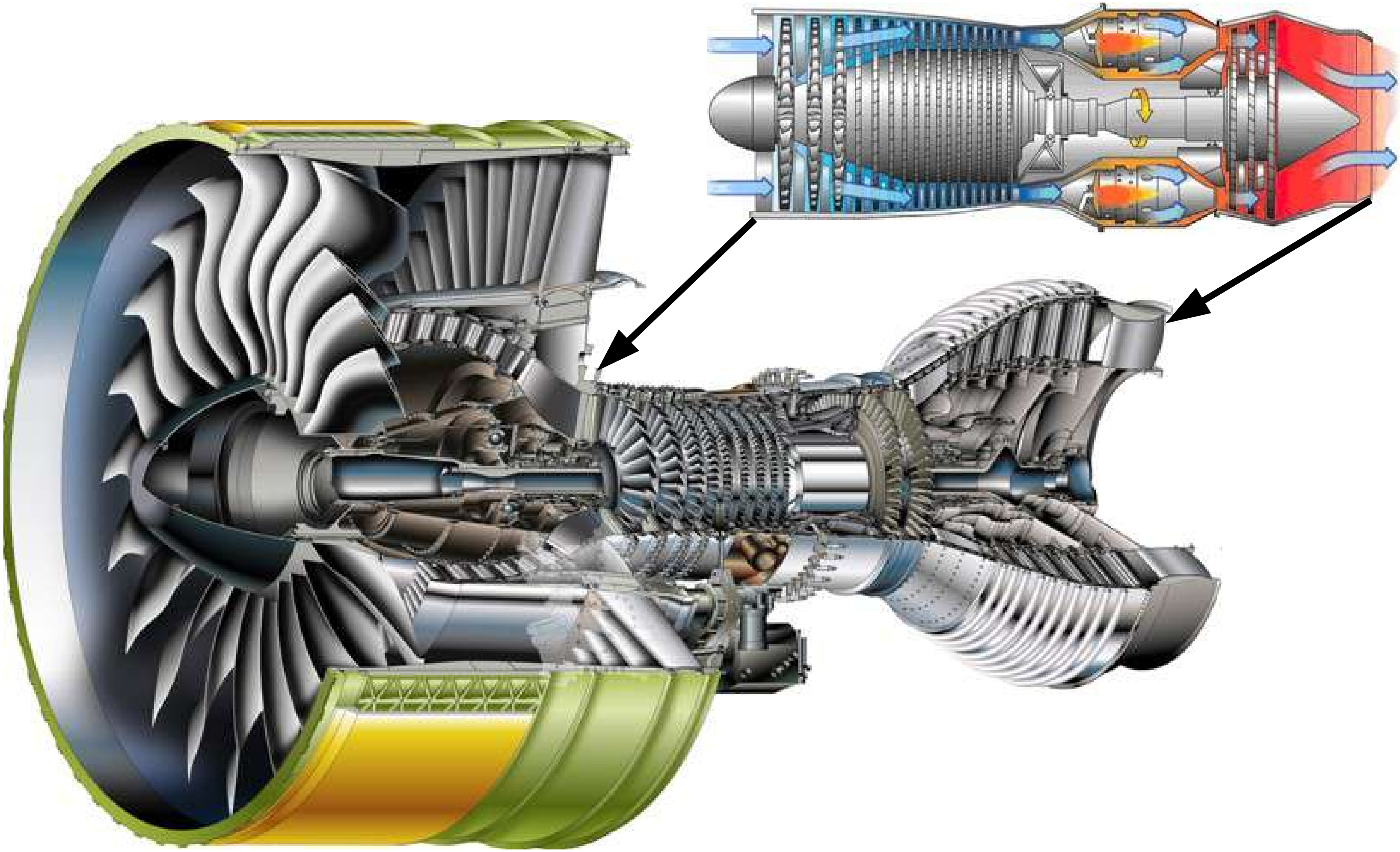
- Potential energy in elastic band: $E = \frac{1}{2}kx^2 = \frac{1}{2}Fx = \frac{1}{2}10 \times 0.1 = 0.5\,\mathrm{J}$
- Kinetic energy in handgun bullet: $E = \frac{1}{2}mv^2 = \frac{1}{2}0.005 \times 300^2 = 225\,\mathrm{J}$
- Potential energy in enormous band: $E = \frac{1}{2}kx^2 = \frac{1}{2}Fx = \frac{1}{2}100 \times 5 = 250\,\mathrm{J}$

# Modern materials: alloys

# Jet engine: military jet

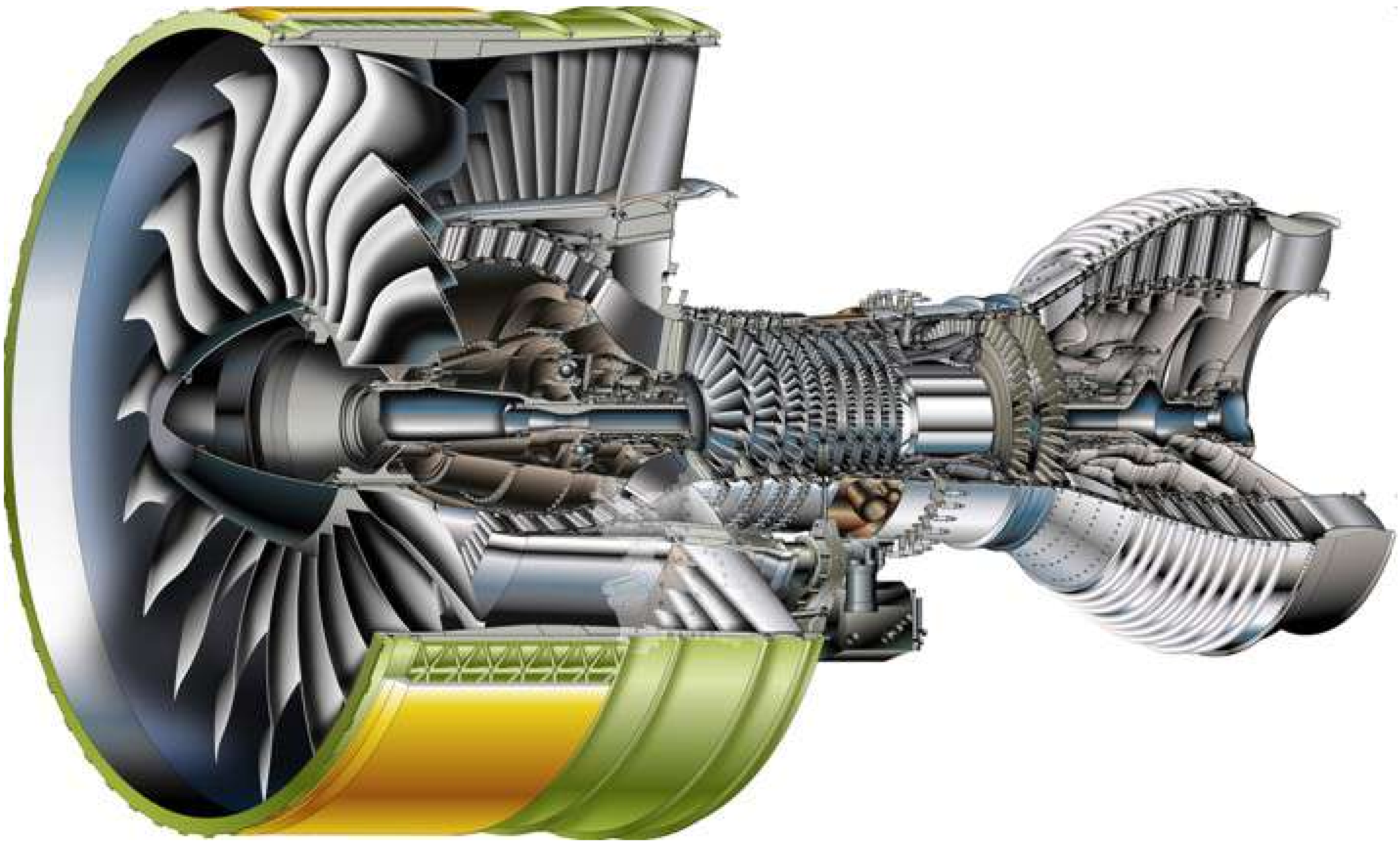


# Jet engine: commercial jet

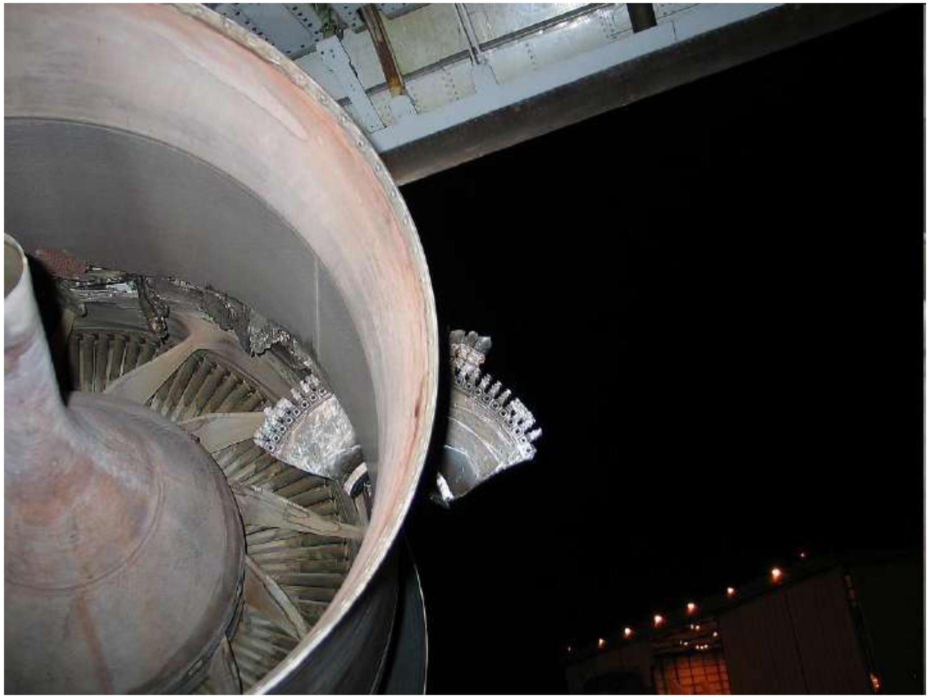


# Jet engine: commercial jet

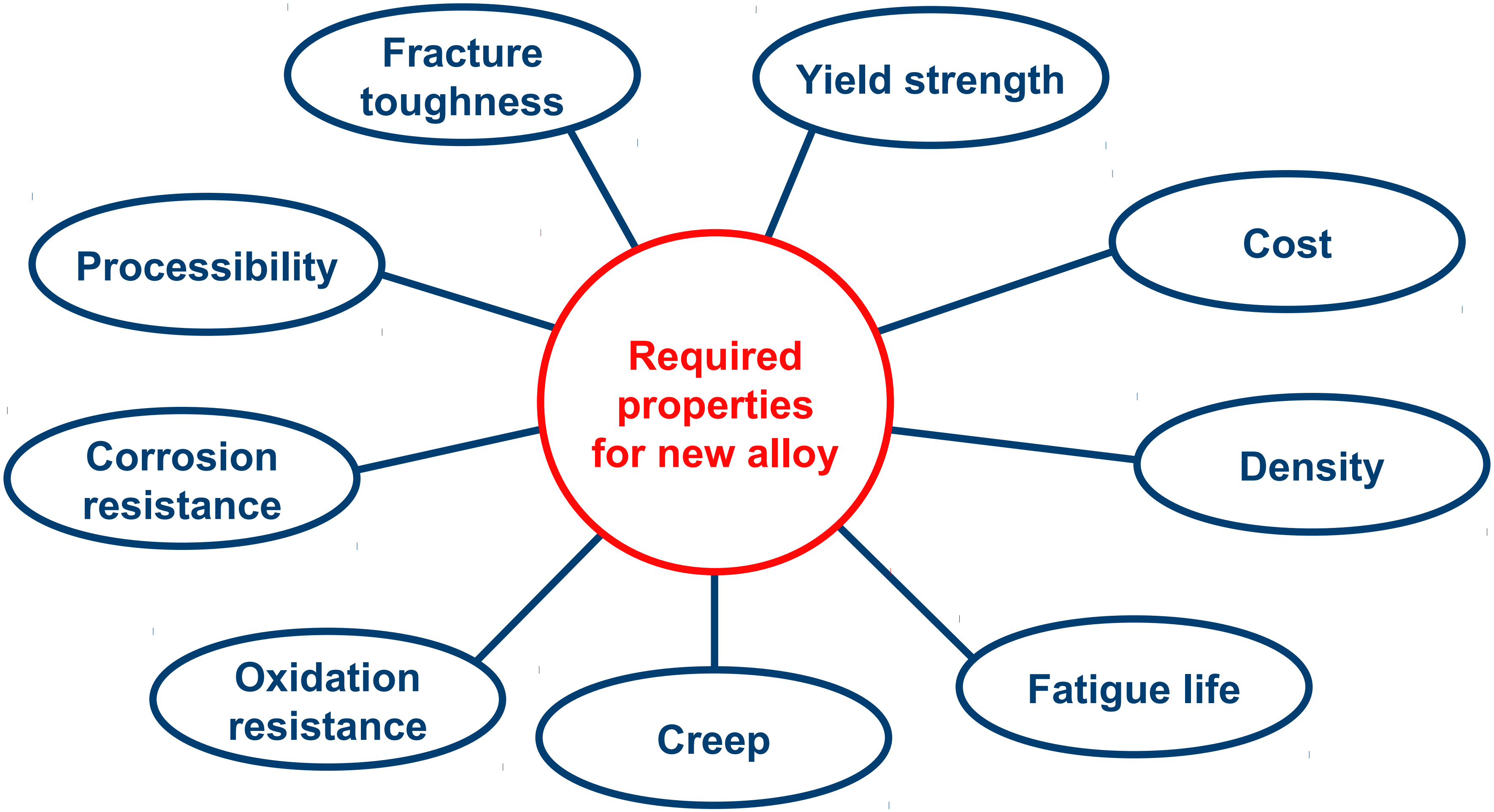
$$E = \frac{1}{2} m v^2 = \frac{p^2}{2m}$$



# Jet engine: turbine discs



# Designing a new alloy – what is required ?



# Multidimensional design space

**Cr**

**Co**

**Mo**

**W**

**Ta**

**Nb**

**Al**

**Ti**

**Fe**

**Mn**

**Si**

**C**

**B**

**Zr**

**Cu**

**N**

**P**

**V**

**Hf**

**Mg**

**Ni**

**and 4 different manufacturing processes**

# Selection of design space

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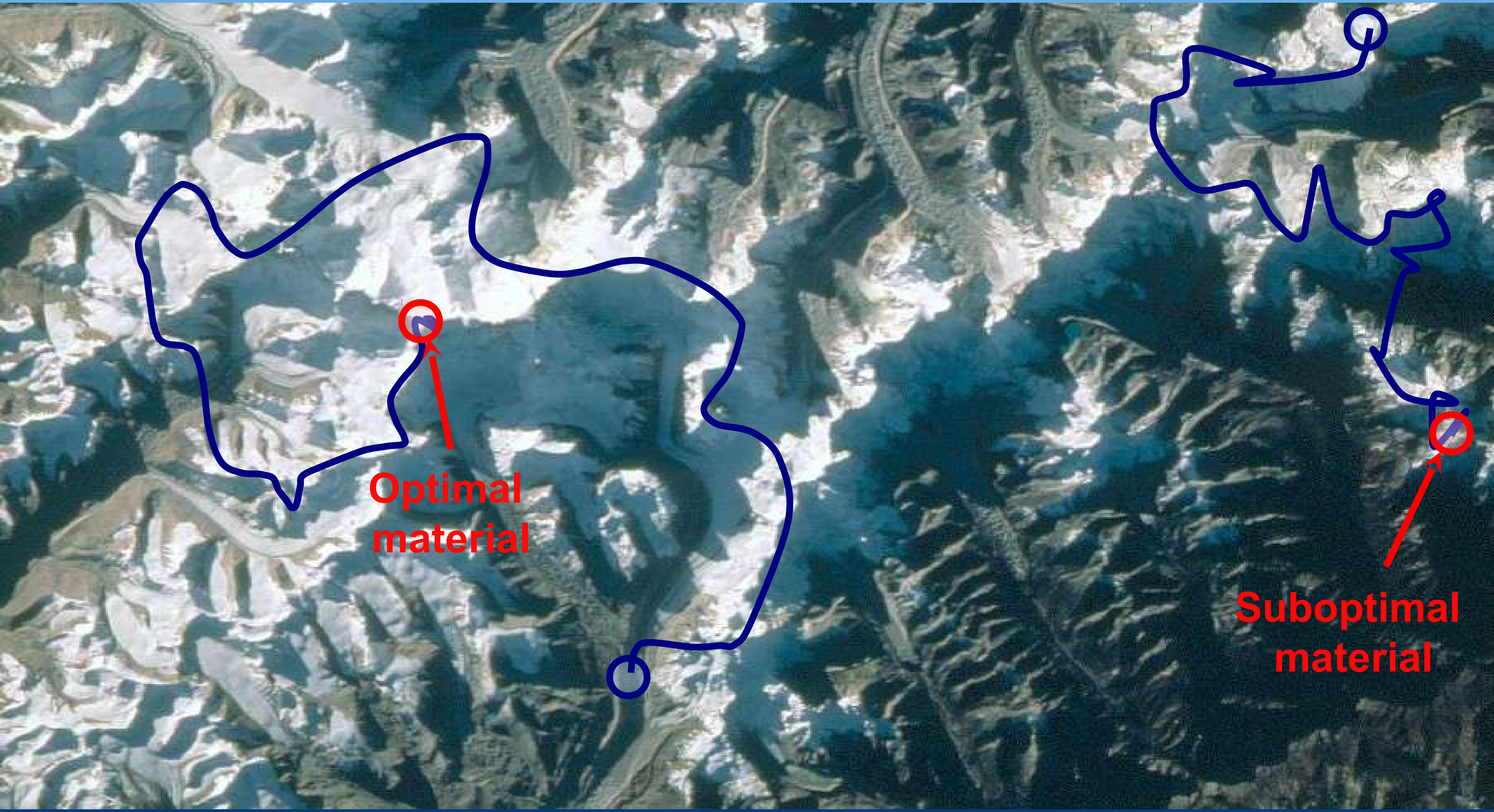
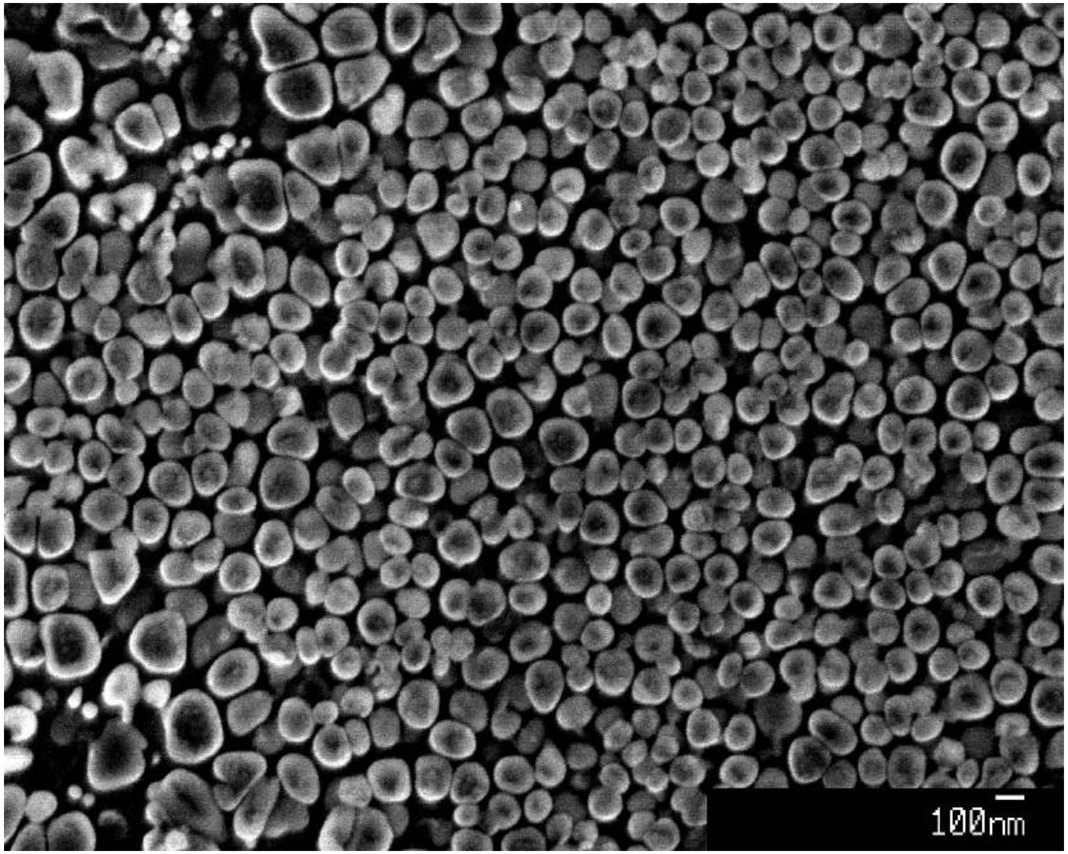
# Automated sampling - parallel optimization



# Predicted material

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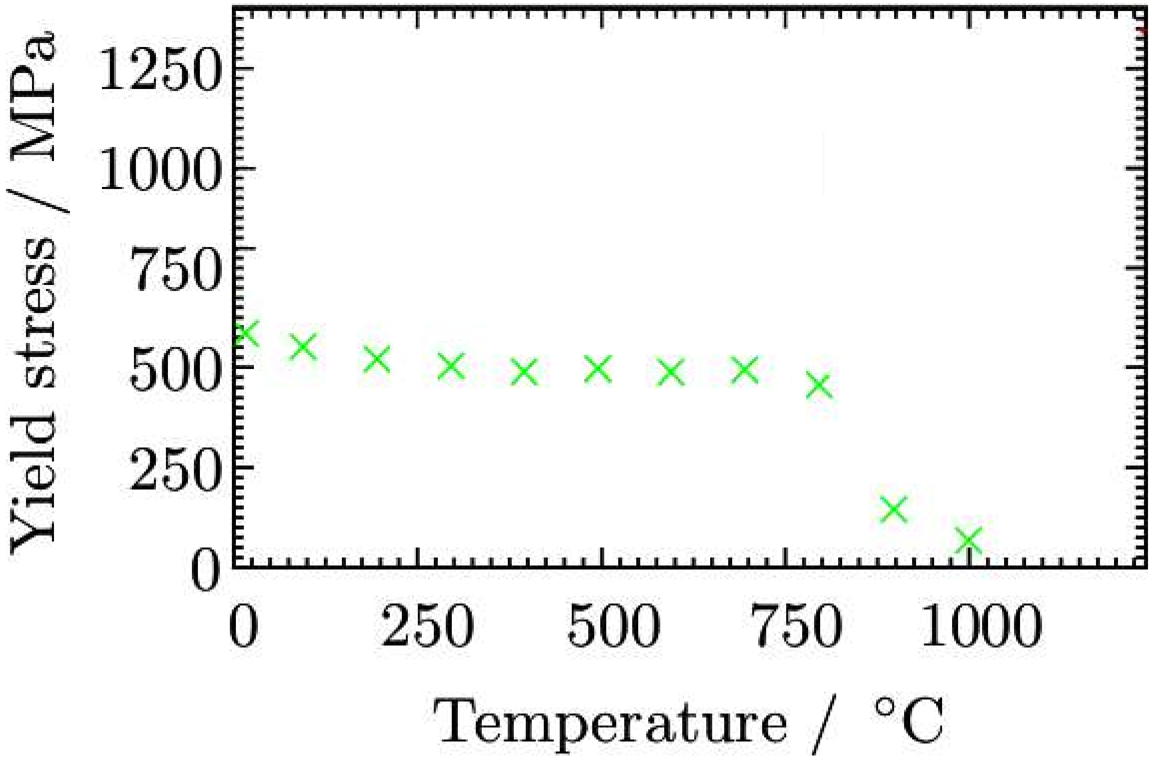

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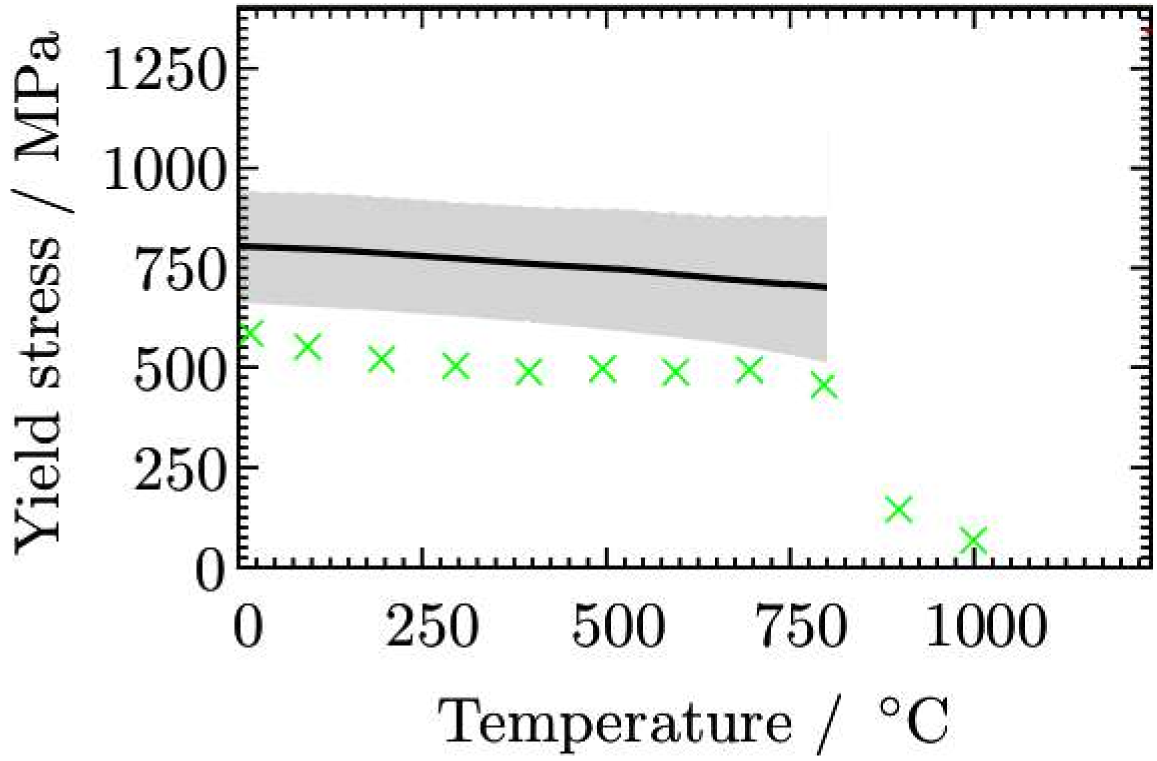

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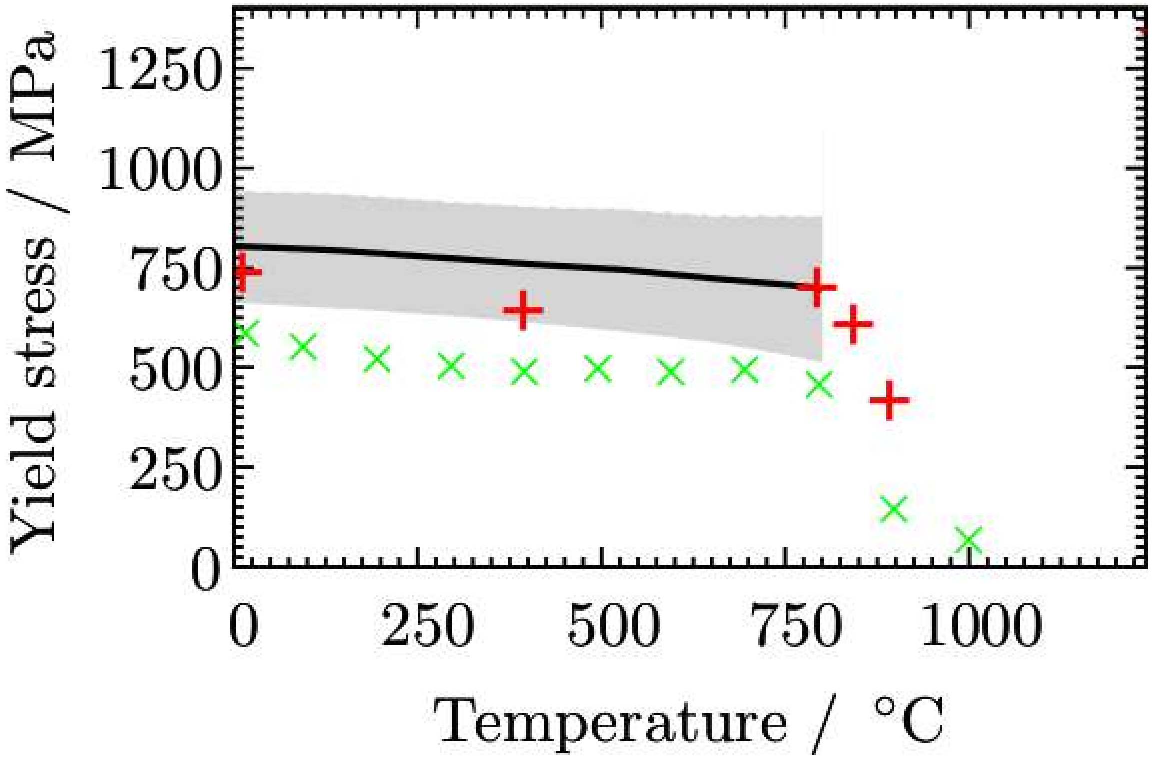

# Conclusions: scientific

- Developed new algorithms to optimize a material’s properties
- Manufactured alloys fulfill physical criteria

# Conclusions: why work in material sciences?

- Union of different sciences that encourages analysis with a variety of techniques – analytical, numerics, and experiments

- Close connection to real-world problems

- Strong academic funding and well-paid industrial jobs