Clean TeQ Holdings Limited

Scandium Market Update

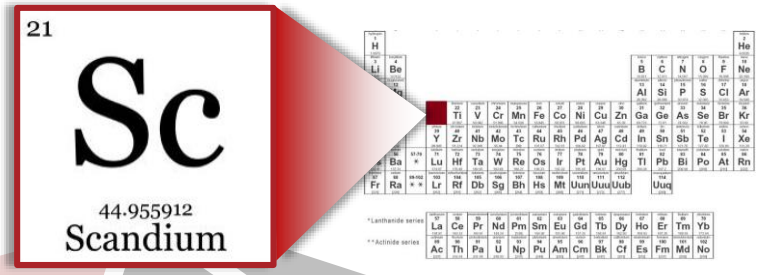
Annual General Meeting

19th November 2015

Creating environmental and economic outcomes for sustainable mining and processing.

CleanTeQ metals

Scandium I Strategic Lightweighting Metal



High Strength Lightweight Alloys for Next Generation Transport




Power Distribution


Forming Technologies


The world needs lightweighting solutions

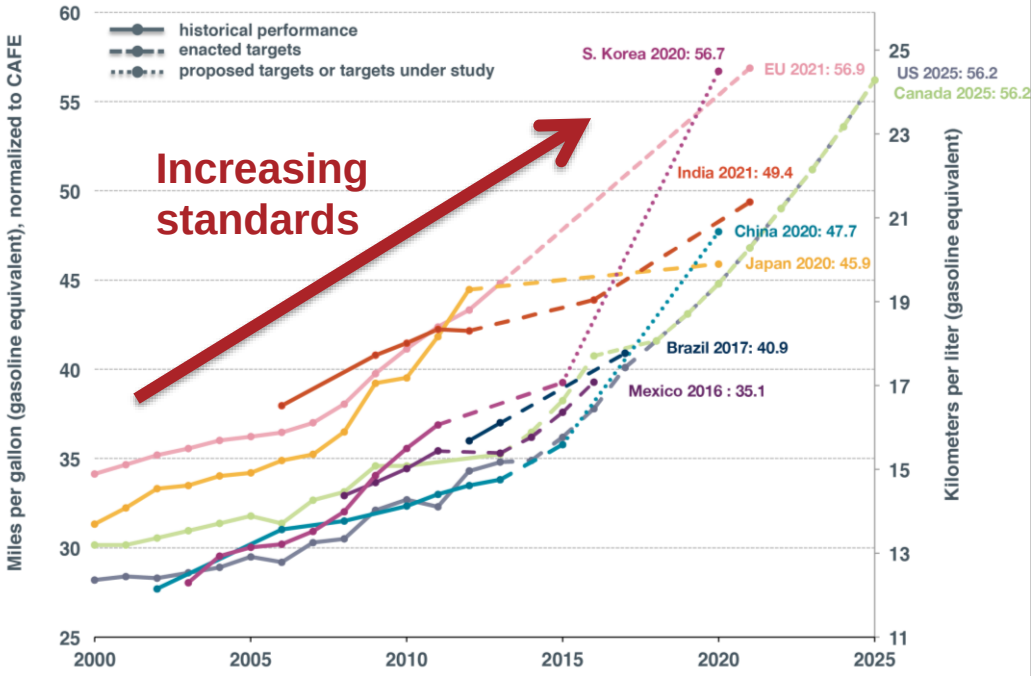
Aluminium will remain a preferred material for lightweighting for decades

Scandium enhances the performance of aluminium in unique and commercially significant ways

Automotive I Lightweighting imperative

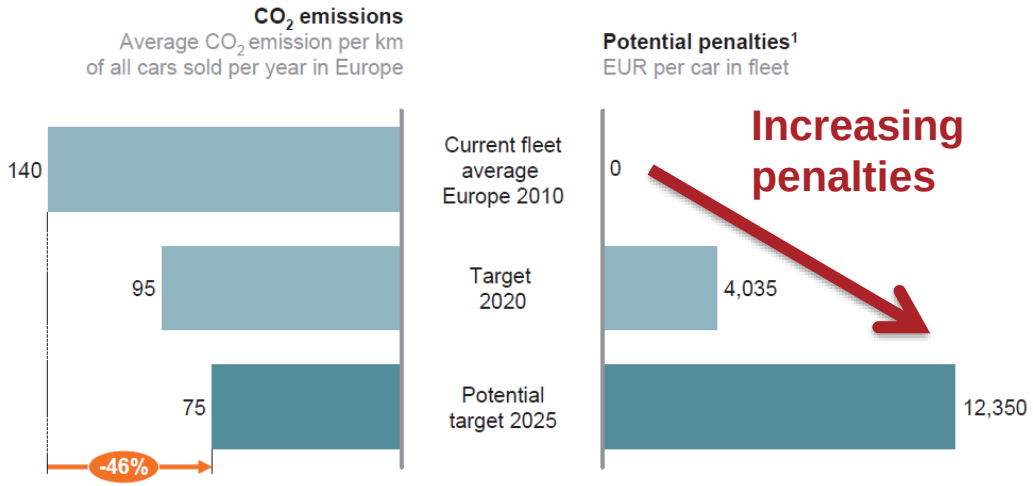
Increasing Fuel Efficiency Targets:

Passenger car miles per gallon, normalised to CAFE (Corporate Average Fuel Economy) Regulations



Source: The International Council of Clean Transportation

Increasing CO_2 Emissions Targets:



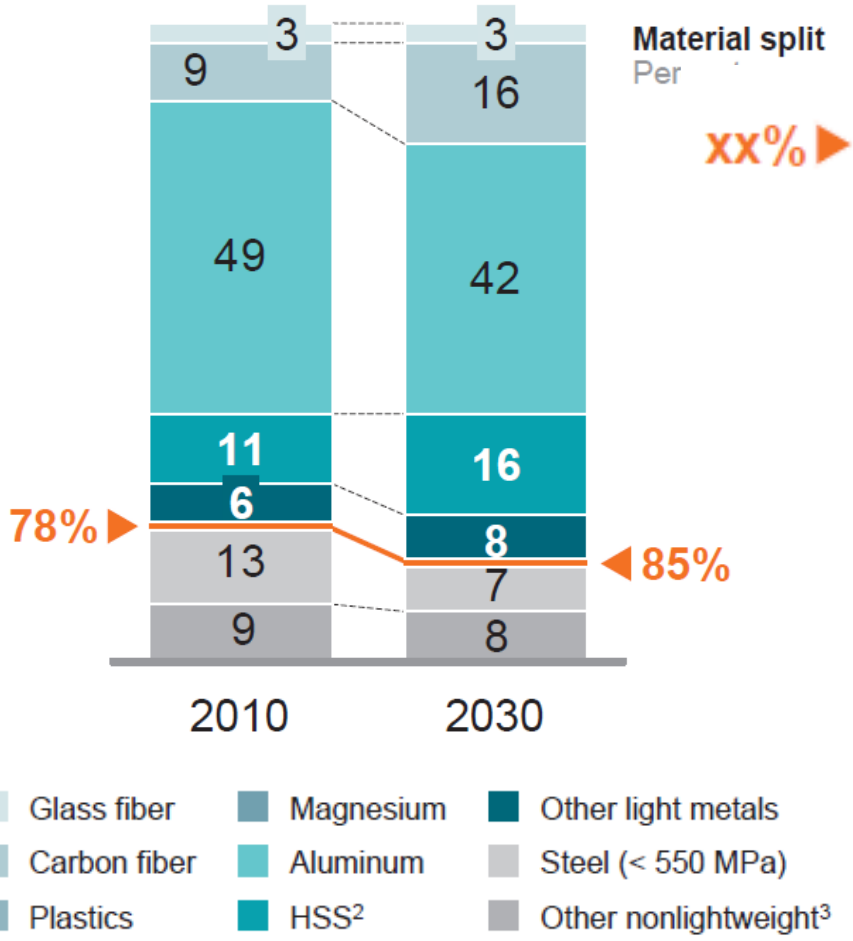
[1] Assumption in comparison to today's average European CO_2 emission of 140g CO_2 per km car; penalties for exceeding CO_2 emissions in 2020: for 1st gram EUR5, 2nd gram EUR15, 3rd gram EUR25, 4th gram and beyond EUR95; penalties in 2025: EUR190 for each gram.

Source: McKinsey

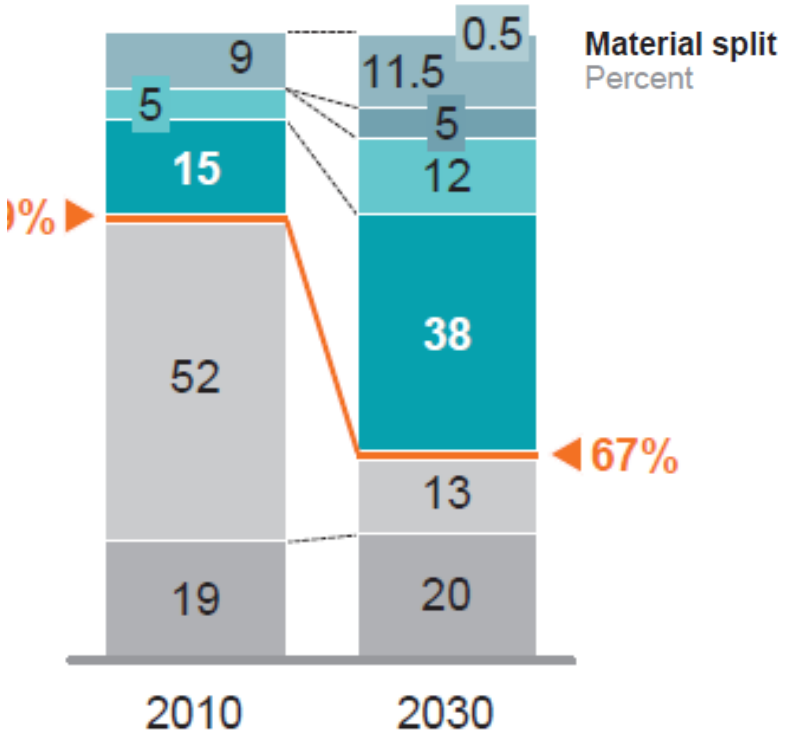
Enforced regulation in combination with limits on engine efficiency is driving industry to lightweight solutions.

Transportation I Lightweight share is rising

While **Commercial Aerospace** is well advanced in lightweight materials…



…**Automotive** is catching up.

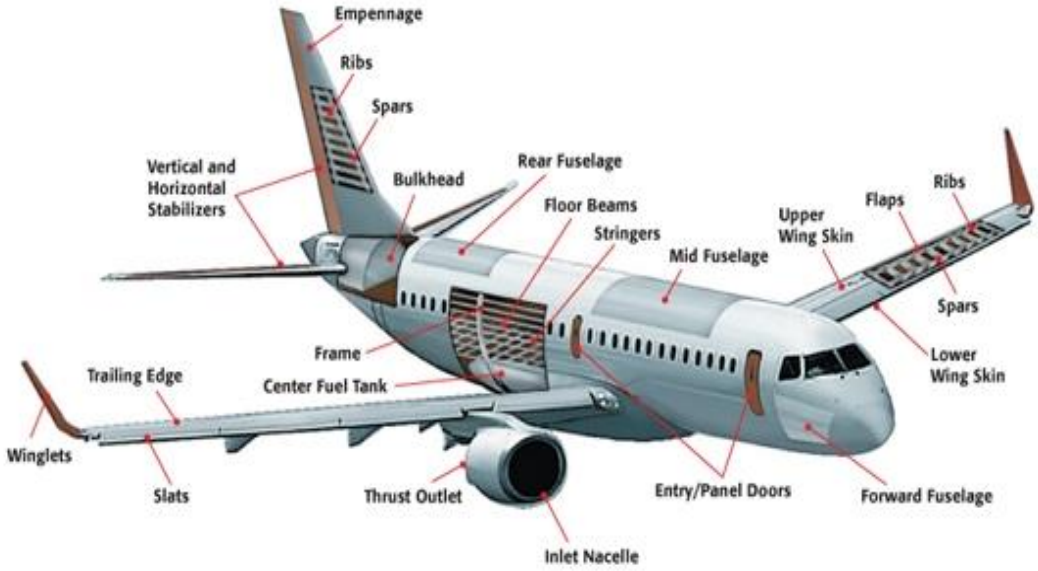


1 HSS, aluminium, magnesium, plastics (beyond current use), glass/carbon fibre
2 High-strength steel (> 550 MPa)
3 Mainly other metals, glass, fluids, interior parts for automotive, etc.

Source: McKinsey

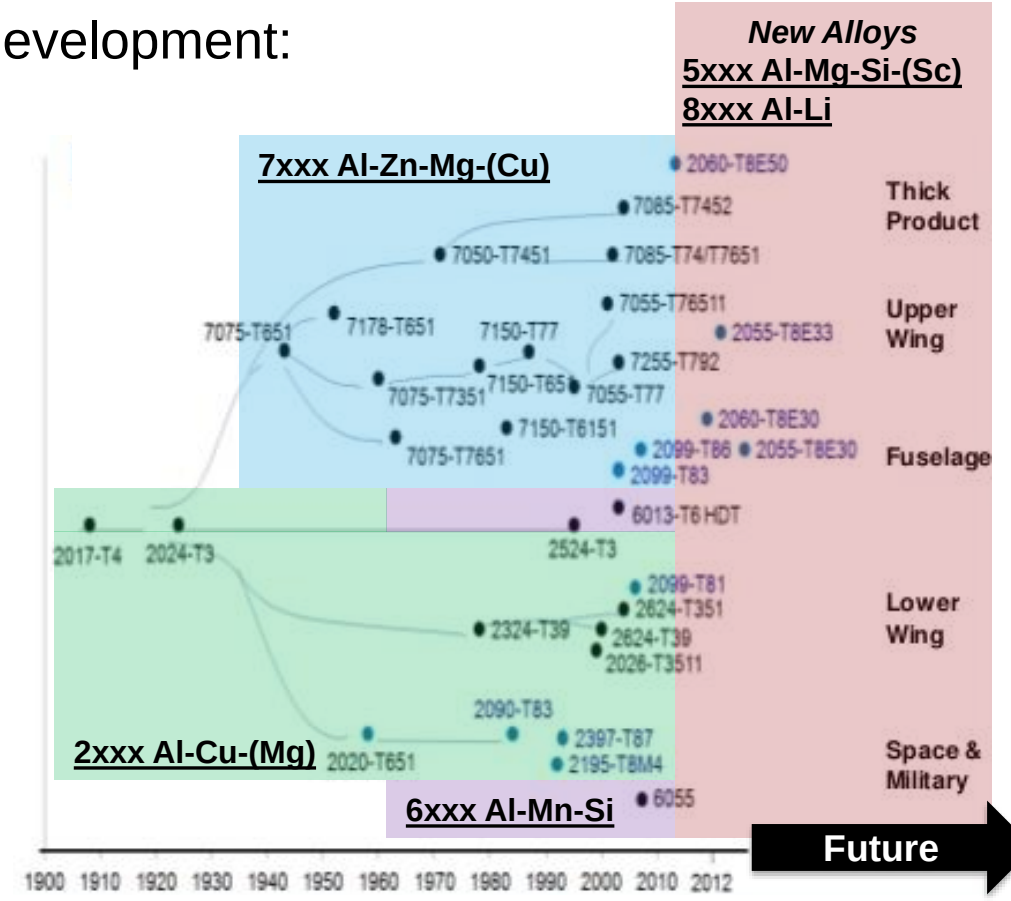
Aerospace I Aluminium alloy applications

The applications of aluminium in aerospace component parts are extensive:



Source: Kaiser Aluminum

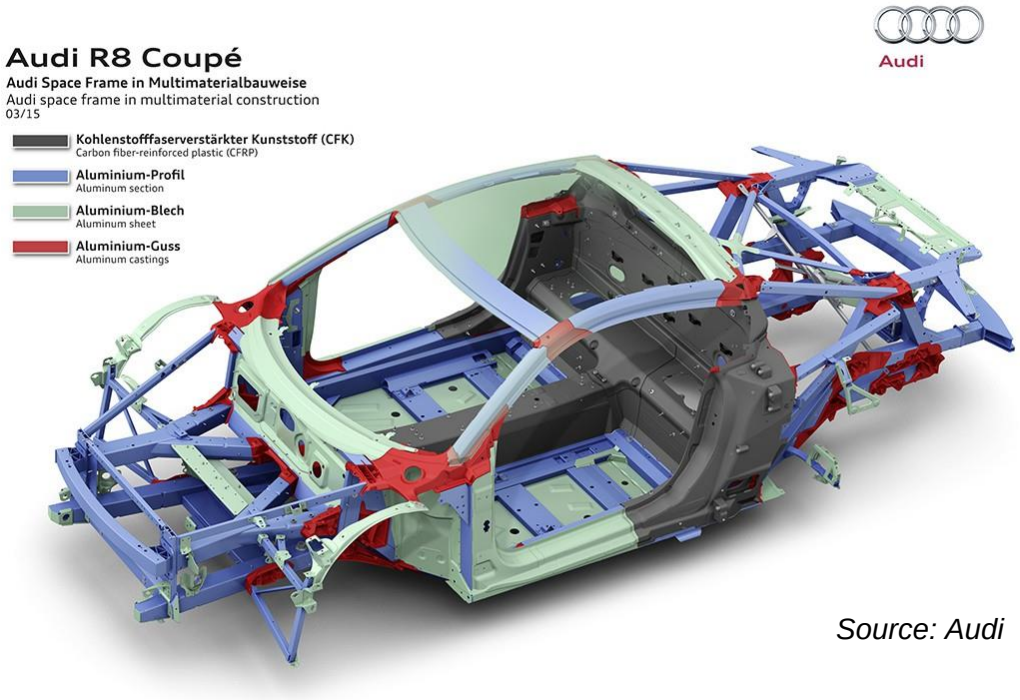
With continuous and increasing alloy development:



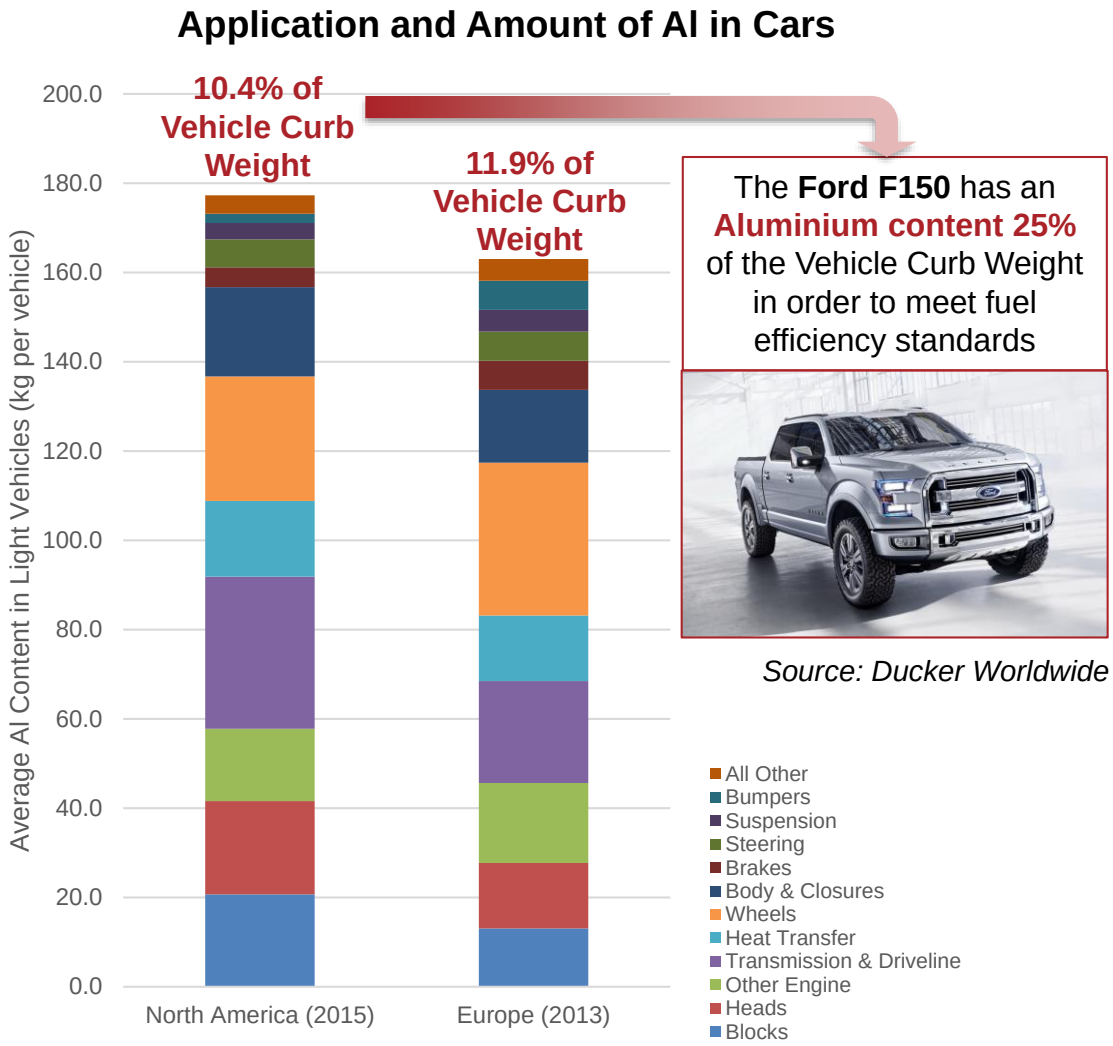
Graph Source: Alcoa

Automotive I Aluminium alloy applications

What was once high-end is now becoming more common in mass produced cars, with component applications over the entire car.



Source: Audi



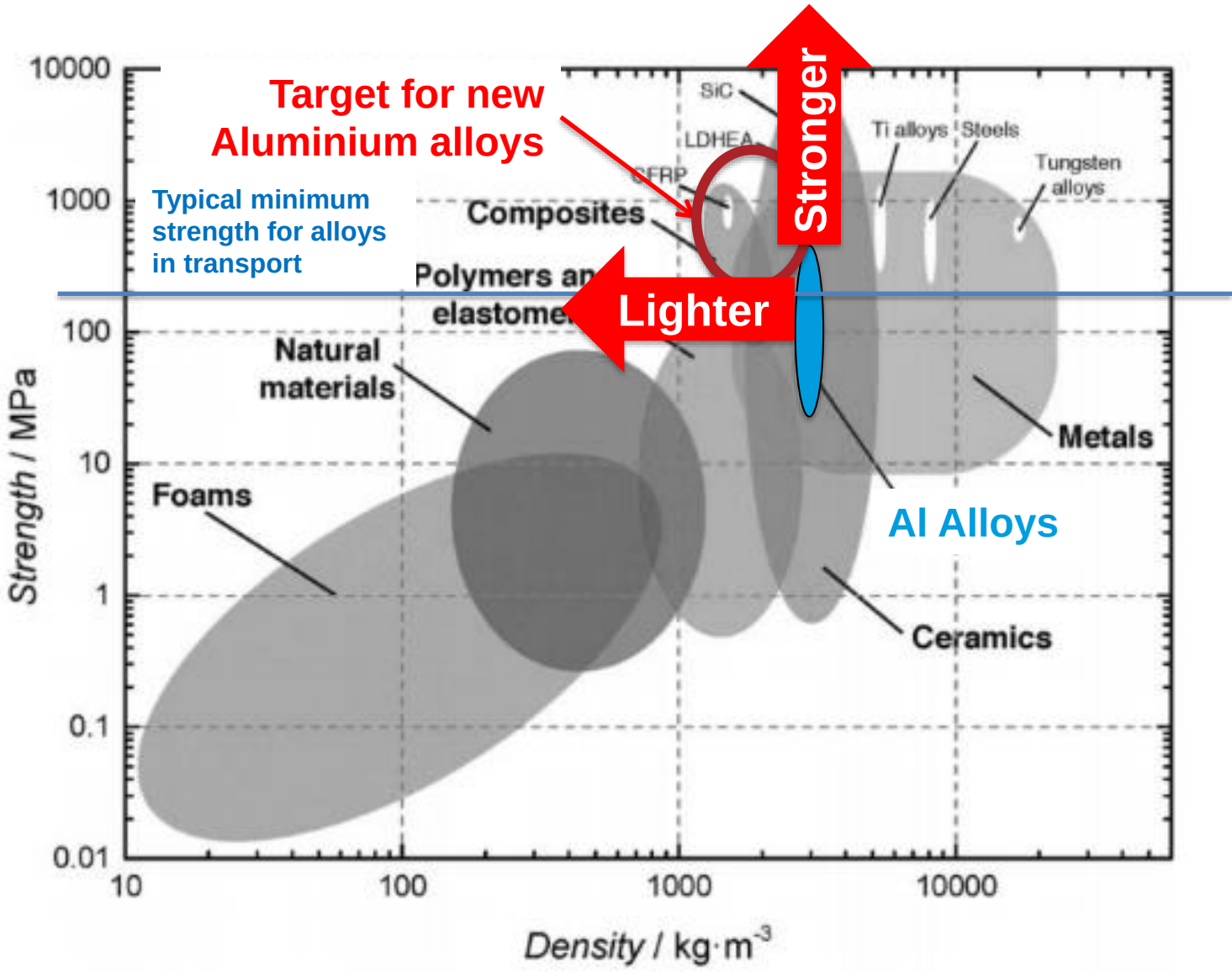
The **Ford F150** has an **Aluminium content 25%** of the Vehicle Curb Weight in order to meet fuel efficiency standards

Source: Ducker Worldwide

Source: Ducker Worldwide

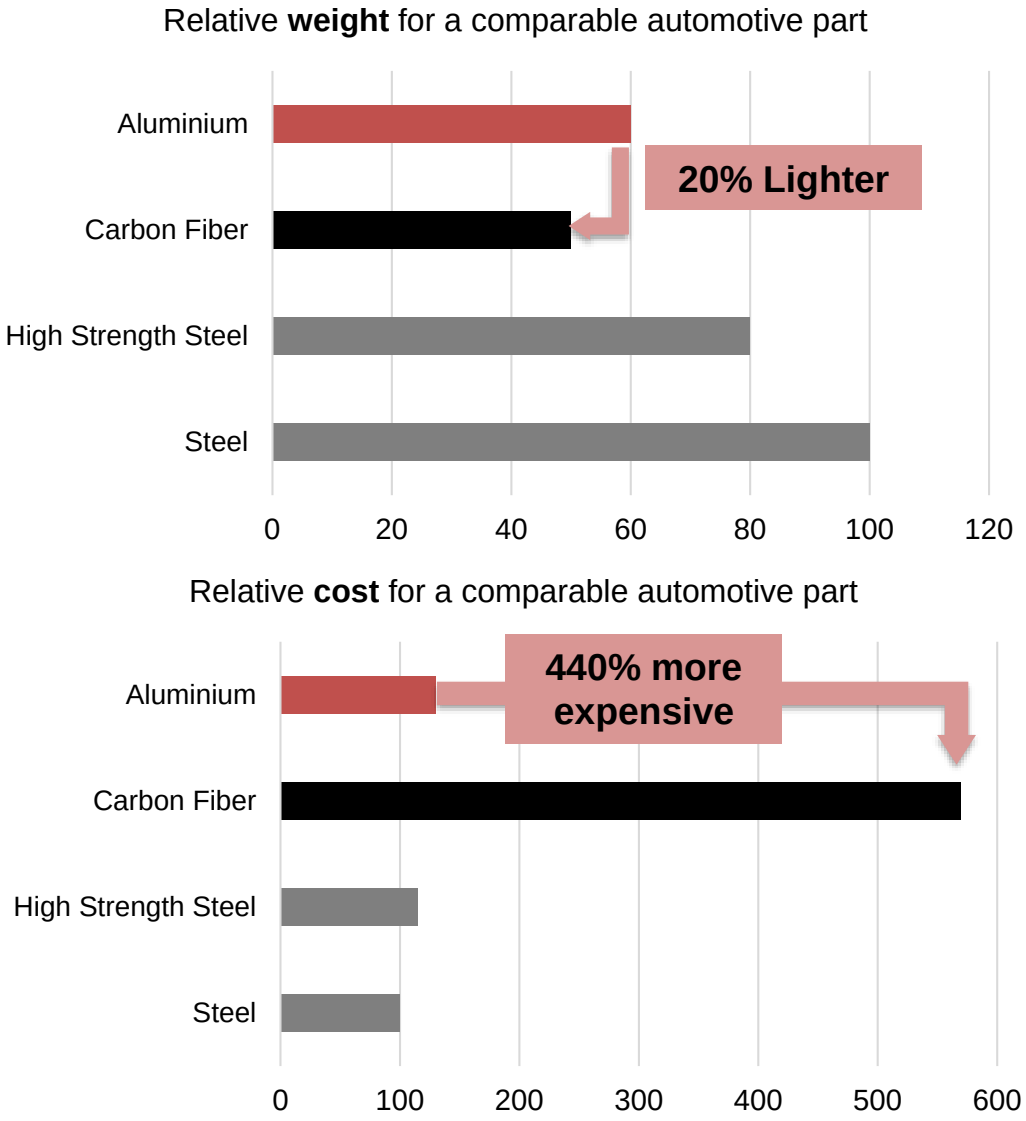
Material Selection I Strength to Weight Ratio

- The first consideration for new alloys is whether the alloy is lighter and stronger than other materials.
- On this consideration alone, composites appear to provide a better solution over alloys.



Graph Source: Elsevier / Khaled M Youssef, et al, 2010

Lightweight Materials I Additional considerations



Note: Steel as 100

Source: McKinsey

However, aluminium alloys have several key advantages over composites, including:

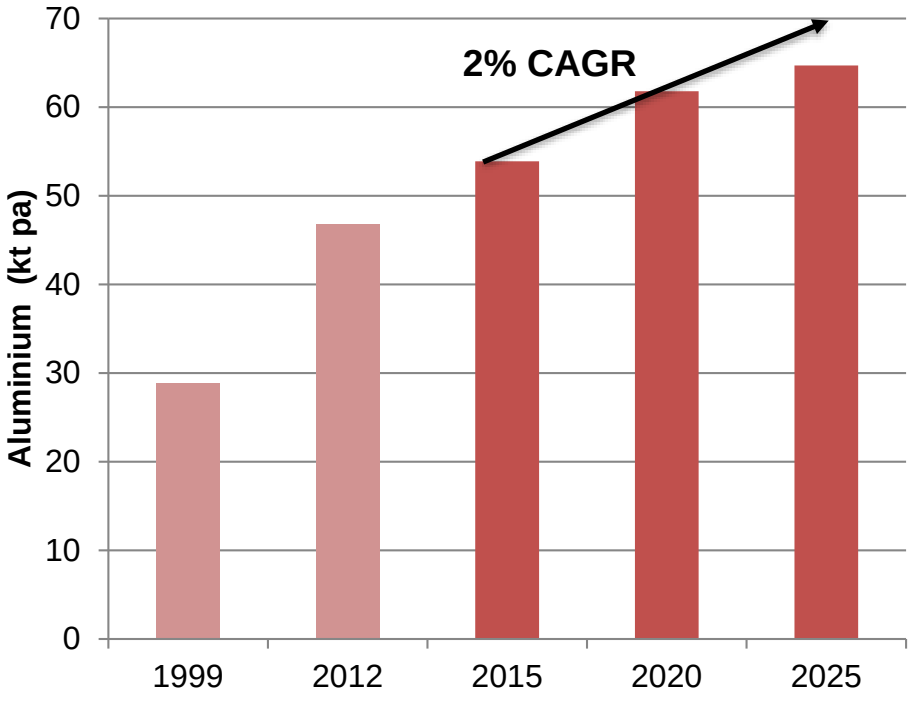
- Lower material cost
- Lower forming/joining costs
- Lower maintenance costs
- Less corrosion
- Ability to recycle materials

Ensuring that aluminium alloys currently provide a more holistic economic outcome.

Transport I Future demand for aluminium

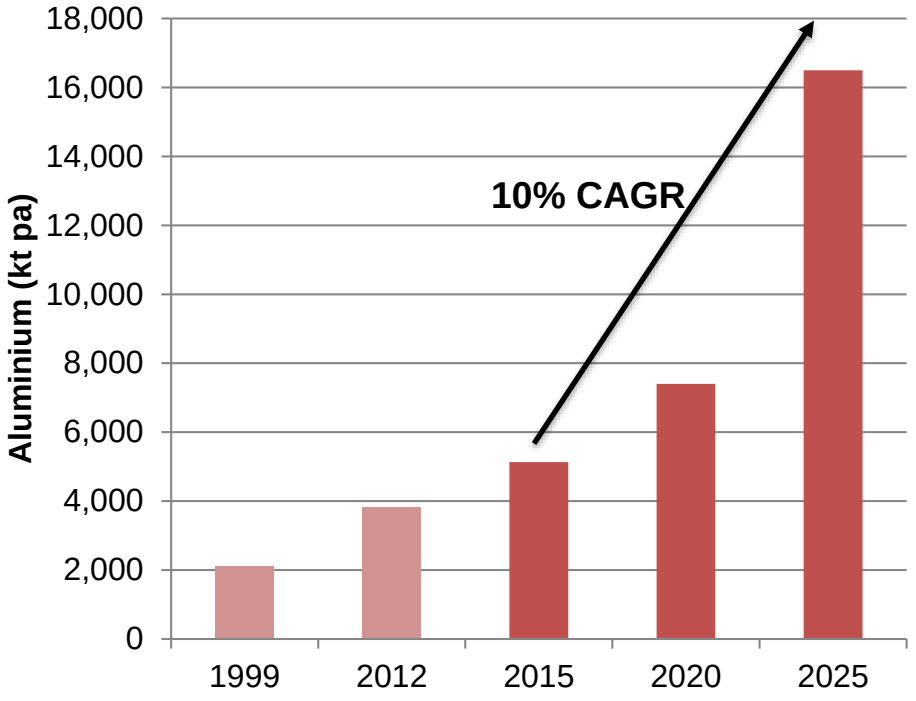
The benefits mean that there is stable and increasing demand for aluminium, particularly in the automotive sector.

Global Aircraft Primary Aluminium Use (History and Forecast)



Source: Deloitte

Global Light Vehicle Primary Aluminium Use (History and Forecast)

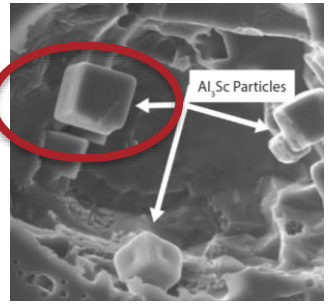


Source: Ducker Worldwide

Assumes avg plane operating empty weight (OEW) of 64t and Al is 60% of OEW

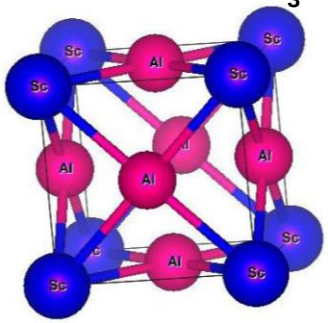
Al Alloys I Scandium impact on grain size and strength

The micro structure of aluminium is fundamentally changed when scandium is added, forming a "cuboid" Al_3Sc structure, rather than long crystals:



Source: AMG Aluminum

Cuboid Structure of Al_3Sc:



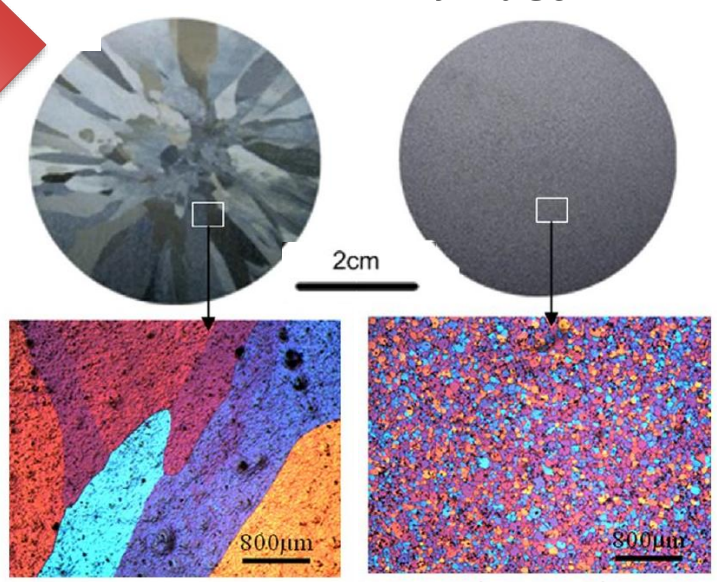
Source: Galav and Joshi, 2014

This leads to finer grains of aluminium being formed.

The implications of this "grain refinement" on the performance of the alloy, including strength, weldability, etc is enormous.

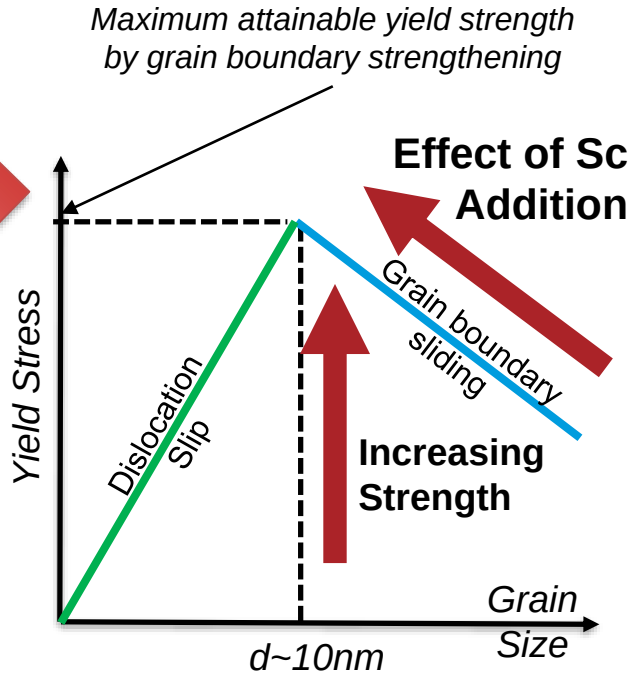
Effect of Sc Addition

0.1% Sc in Al *0.7% Sc in Al*



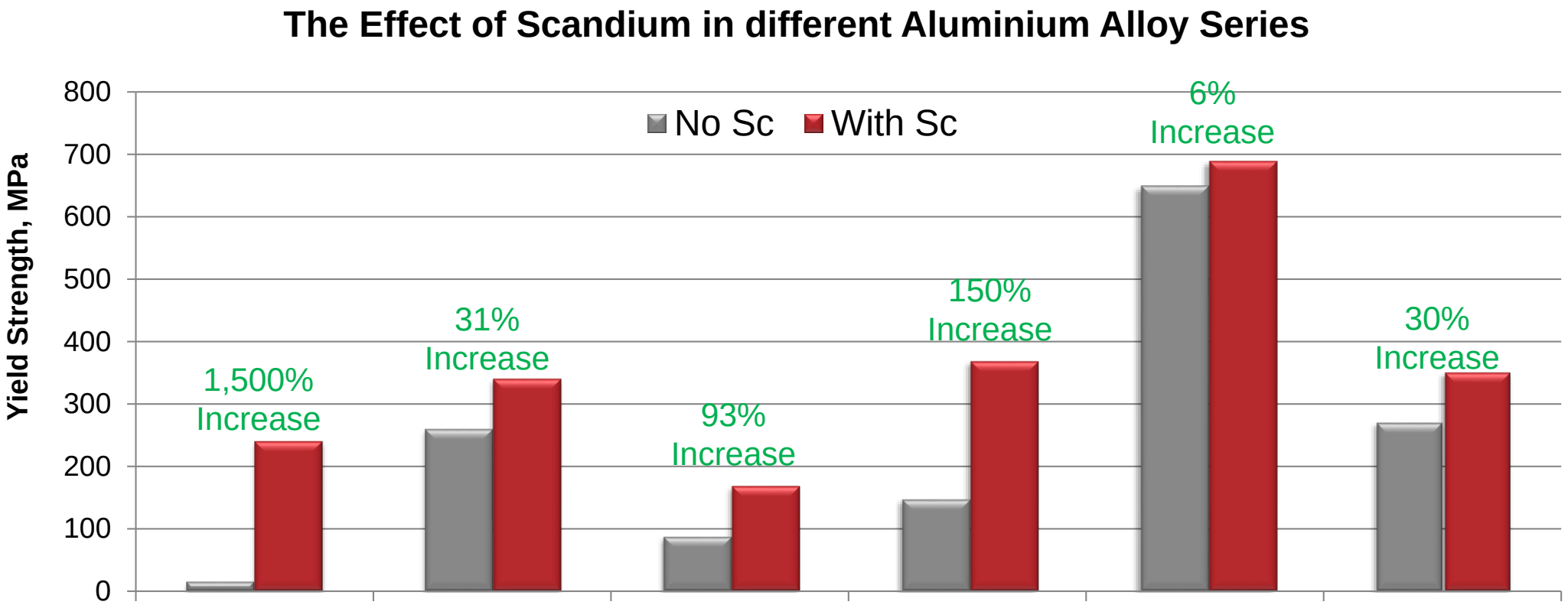
Source: Zhang et al, 2013

Finer grains lead to less "sliding" between grain boundaries. Scandium addition helps aluminium increase its overall strength by impeding the grain movement by making the grains finer:



Source: Hall Petch Strengthening Limit

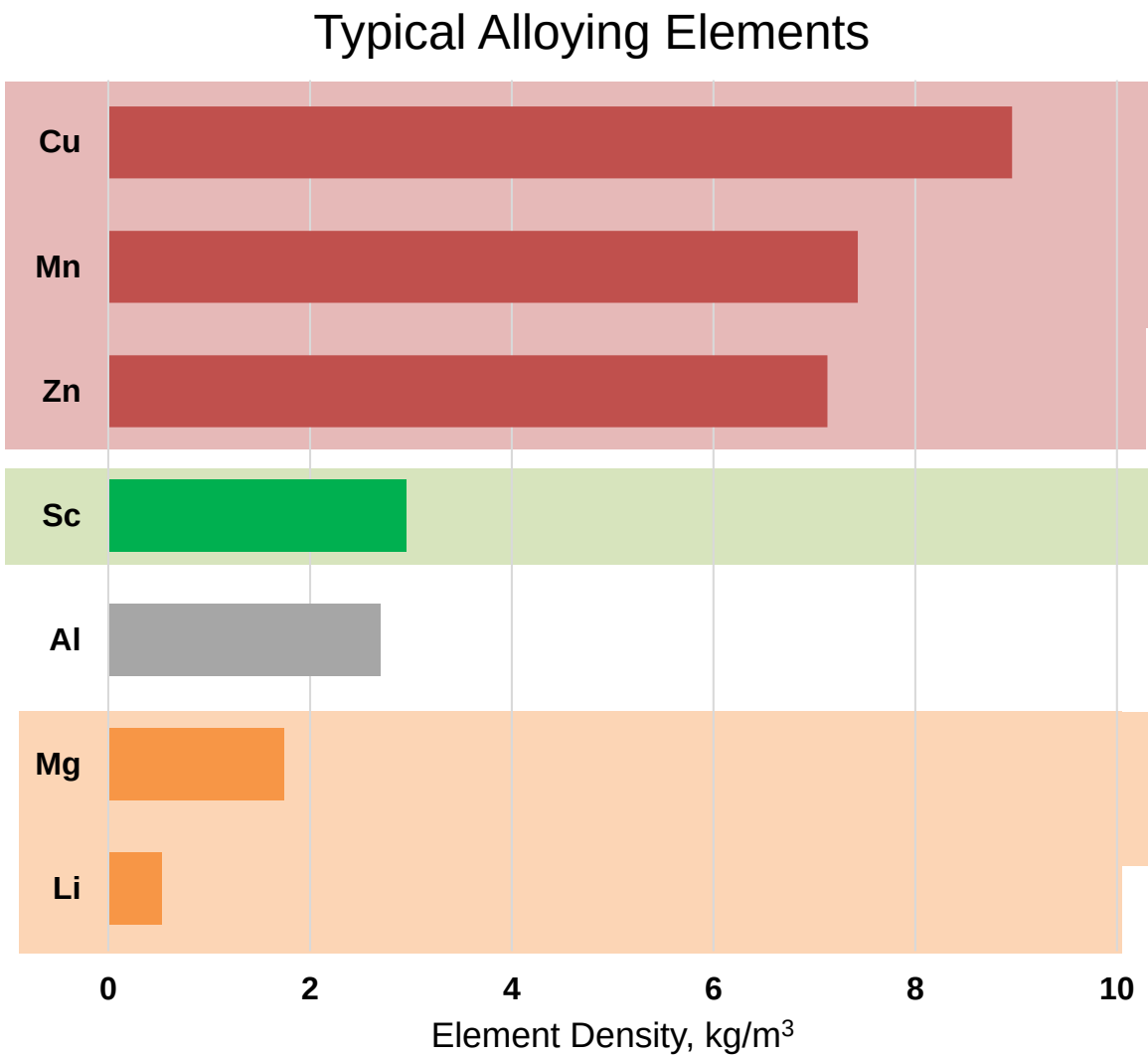
Al-Sc Alloys I Strength with Scandium Addition



Alloy System	1xxx	2xxx	3xxx	5xxx	7xxx	8xxx
Alloy	Al	Al-Cu	Al-Mn	Al-Mg	Al-Zn-Mg(-Cu)	Al-Li-(Cu)
Potential Sc Content wt%	0.2-0.4%	0.01-0.06%	0.1-0.26%	0.05-0.5%	0.1-0.26%	0.1-0.2%
Applications	Packaging, cans, electrical conductors	Structural, Aerospace	Cans, heat exchangers	Beverage, marine, automotive, aerospace	Aerospace, automotive	Aerospace, automotive

Source: Hydro Aluminium R&D Sunndal, 2012

Scandium I Alloy strength to weight ratio



Adds strength but heavier alloy

Scandium provides the greatest increase in aluminium alloy strength to weight ratio[1]

Makes the alloy lighter, but Limited strength addition

1: K. Venkateswarlu, et al, High Strength Aluminum Alloys with Emphasis on Scandium Addition, 2008

Aerospace I Al-Sc Alloy Key Benefits

Physical Characteristics	Functional Benefits	Commercial Benefits
Fine Grain	Strength Hardness	• Make fit-for-purpose components with less metal • Reduce susceptibility to damage/improve crack resistance
Superplasticity	Formability	• Reduce total metal • Simplify manufacturing; e.g. double curvature sheets Shorten build time
Recrystallization Resistance	Formability Weldability	• Reduce total metal • Simplify manufacturing; e.g. remove need for rivets • Shorten build time
Corrosion Resistance	Elimination of coatings and cladding (incl. chromium)	• Reduce total materials • Simplify manufacturing; e.g. curing/joining • Shorten build time

Lower net capital cost (buy-to-fly ratio) ✓

Lower maintenance cost ✓

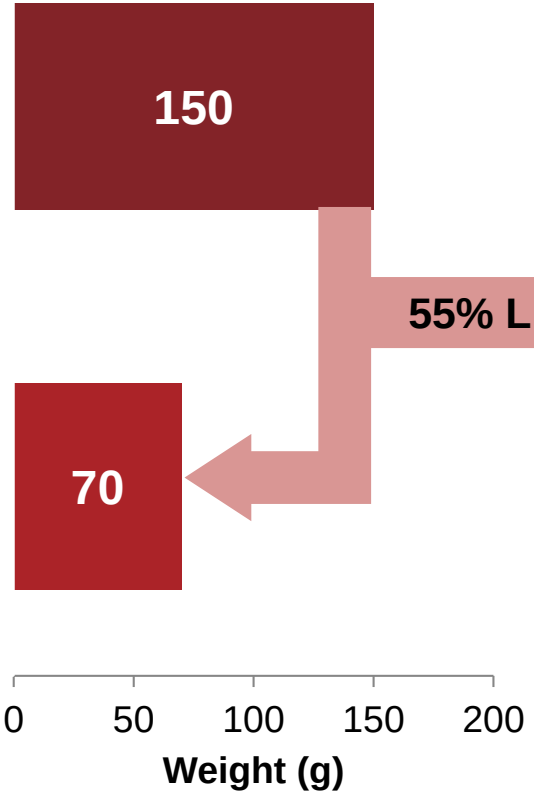
Increased fuel efficiency ✓

Al-Sc Alloys I Weight saving by specialised forming

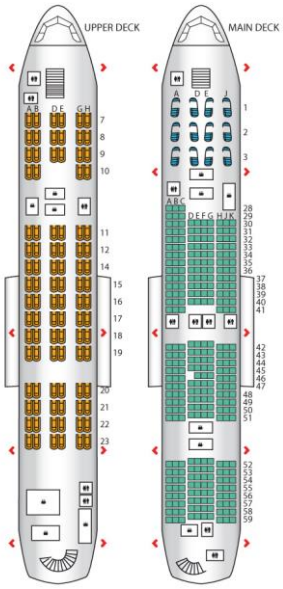
Al-Sc alloys combined with additive manufacturing can provide weight reduction through optimised design:

Weight per belt buckle

Traditional Design:



Optimised Design:



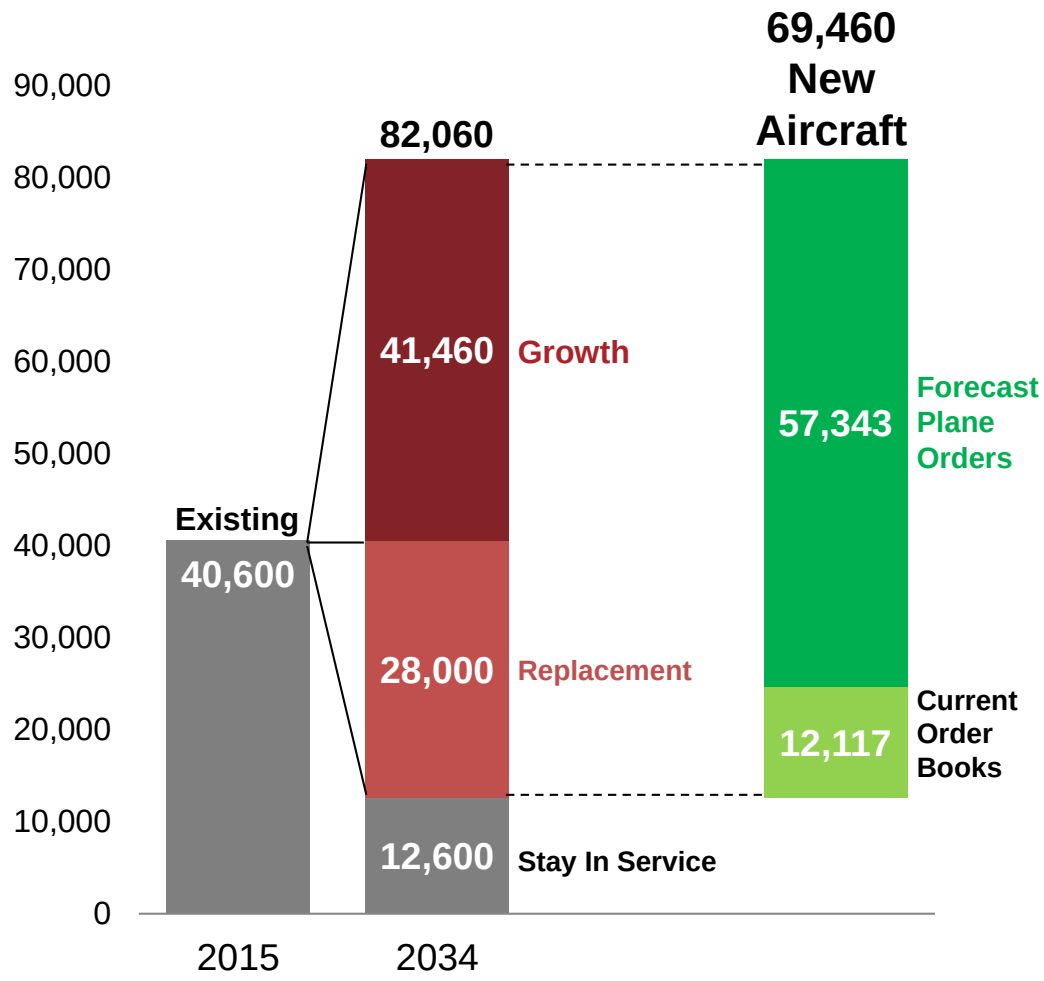
On an Airbus A380 with economy seating (853 seats) this would equal a total weight reduction of **72.5kg.**

Over the life of the aircraft, this equates to 3.3 million litres of fuel or **AUD$3.1M.**

Source: Roland Berger

Aerospace I Forecast Aircraft Production

Airbus & Boeing Fleet In Service, 2015-2034:



Current backlog of aircraft orders is >12,000 planes, requiring an estimated 0.45 million tonnes of aluminium.

This represents 10 years of quantifiable market potential.

By 2034 **more than 2.6 million tonnes of aluminium alloys** will be required over this period.

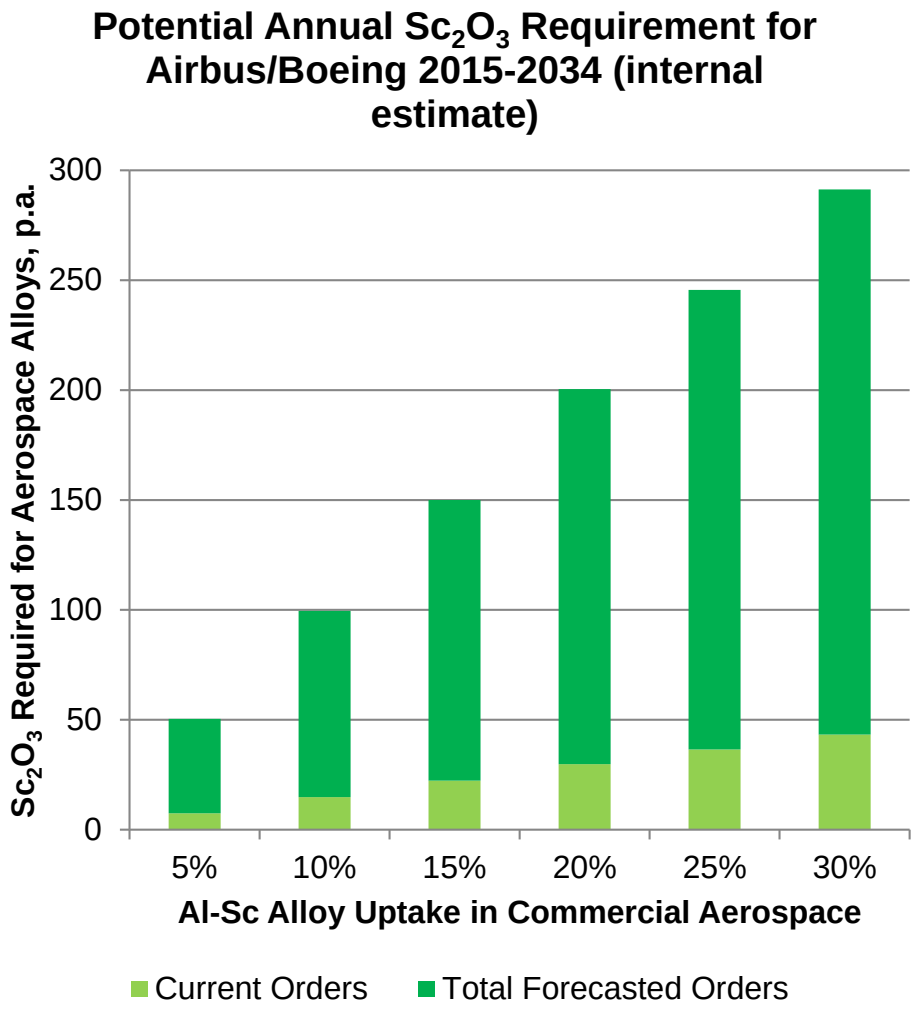
Source: http://www.airbus.com/company/market/orders-deliveries/, http://www.boeing.com/commercial/

Aerospace I Al-Sc Alloy Uptake Potential

With the current back log of orders Boeing and Airbus have today and an uptake of 5-20% of a 0.2% Al-Sc alloy would equate to an immediate potential demand of 10-30tpa of Sc_2O_3.

Realisation of the current forecasts and considering only a 5-20% uptake of a 0.2% Al-Sc alloy would require **50-200tpa of Sc_2O_3** for Airbus and Boeing's order books alone.

While Airbus and Boeing provide a solid base for potential Al-Sc demand, uptake into the broader market, including small planes, helicopters, etc, has the potential to further increase the upside.



Assumes 0.2% Al-Sc alloy used replacing existing Al or Al alloy components. Assumed as average Al content per empty operating weight of 60%.

Empty Operating weight, Aluminium content Source, Airbus, Boeing

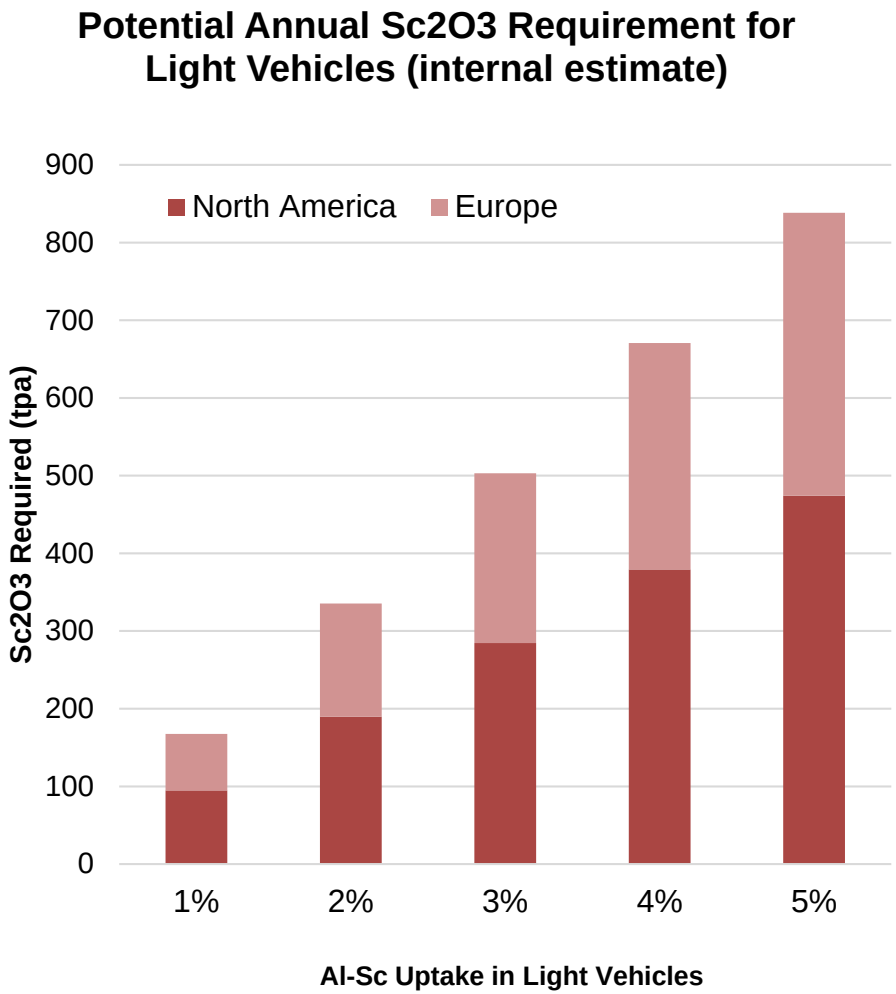
Automotive I Al-Sc Alloy Uptake Potential

Only a 1% uptake of a 0.2% Al-Sc alloy would require **167tpa of Sc_2O_3** for just the North American and European markets.

Taking into account a 10% CAGR in global use of aluminium in light vehicles, a modest 1% uptake (~1.5kg per car) of Al-Sc by **2025 would be 433tpa Sc_2O_3**.

Key considerations:

- Required scandium price point for widespread adoption
- Identification of niche components to facilitate uptake.
- JV's with auto sector players involving the entire supply chain



Note: Assumes 0.2% Al-Sc alloy used replacing existing Al or Al alloy components.

Source: Ducker Worldwide

Al-Sc Alloys I Other Emerging Applications

- Emerging industries which can grow the scandium market…
  - **Rail and marine** – High powered magnets used in maglev trains; corrosion resistant boat hulls
  - **High value packaging** – aluminium cans, foils, etc
  - **Construction**
  - **High voltage transmission wire** – high efficiency due to Sc-Al alloys having high thermal capacity

- And let's not forget...

  - **Solid oxide fuel cells** – distributed electricity generation from natural gas
  - **Lighting** – manufacture of natural light

…if the correct price point of scandium is reached.