

“The Master Alloy of Al-Nb-B”

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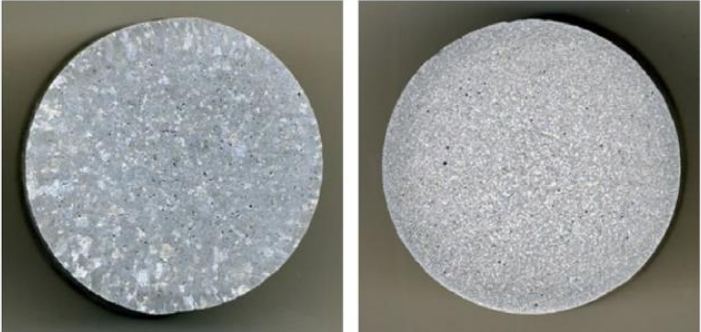
- *Motivation*
- *Master Alloy Design*
- *Production Process Development*
- *Application as Grain Refiner*
- *Future*

Al-Nb-B Master Alloy

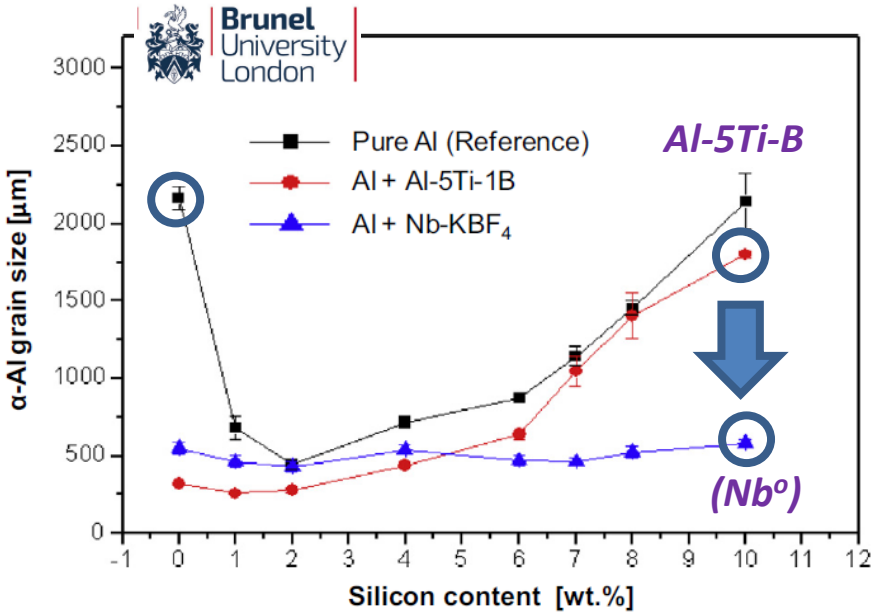


For the aluminium and automotive industries

The use of niobium as grain refining compound NbB_2 for Al-Si cast parts



Joe Quinn, The Aluminum Association: "The auto opportunity: North American market trends" 7th Int. Aluminum Congress and ExpoAlumínio, São Paulo, Brazil, June 8 2016



Benefits:

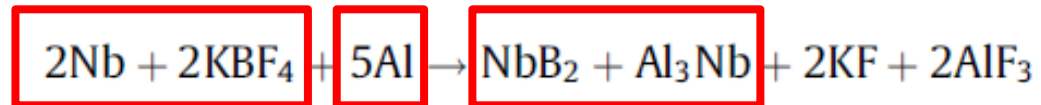
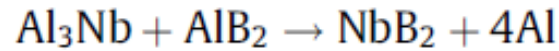
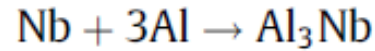
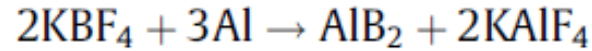
- *Castability/Soundness of thin and complex parts*
- *Less porosity and hot tearing*
- *Increase of mechanical properties/thoughness*
- *Better homogeneity of properties*
- *Potential weight savings of up to 30 % with no loss of strength*

M. Nowak, L. Bolzoni, N. Hari Babu. Grain refinement of Al-Si alloys by Nb-B inoculation. Part I: Concept development and effect on binary alloys. Materials and Design 66 (2015) 366-375. BCAST

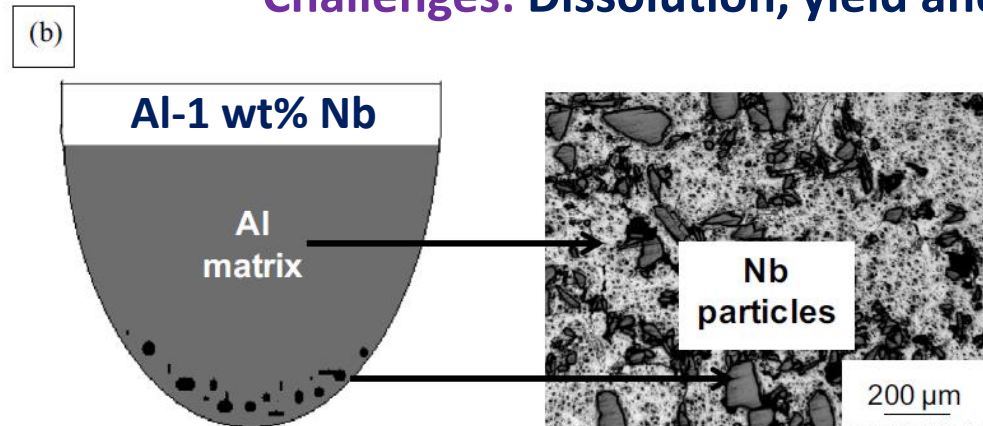
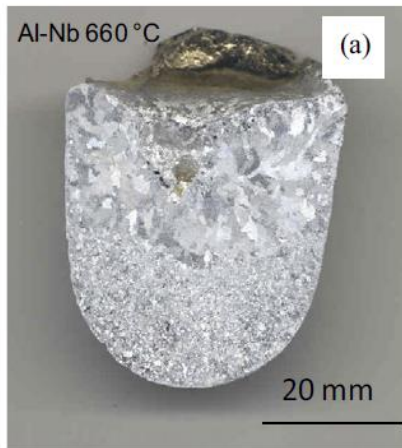
Materials:

- Nb metal powder (<45 um)
- KBF_4

Reactions:



Challenges: Dissolution, yield and cost



M. Nowak, Refiner for aluminium-silicon alloys. PhD thesis BCAST, Brunel University, September. 2011.

M. Nowak, L. Bolzoni, N. Hari Babu. Grain refinement of Al-Si alloys by Nb-B inoculation. Part I: Concept development and effect on binary alloys. Materials and Design 66 (2015) 366–375. BCAST

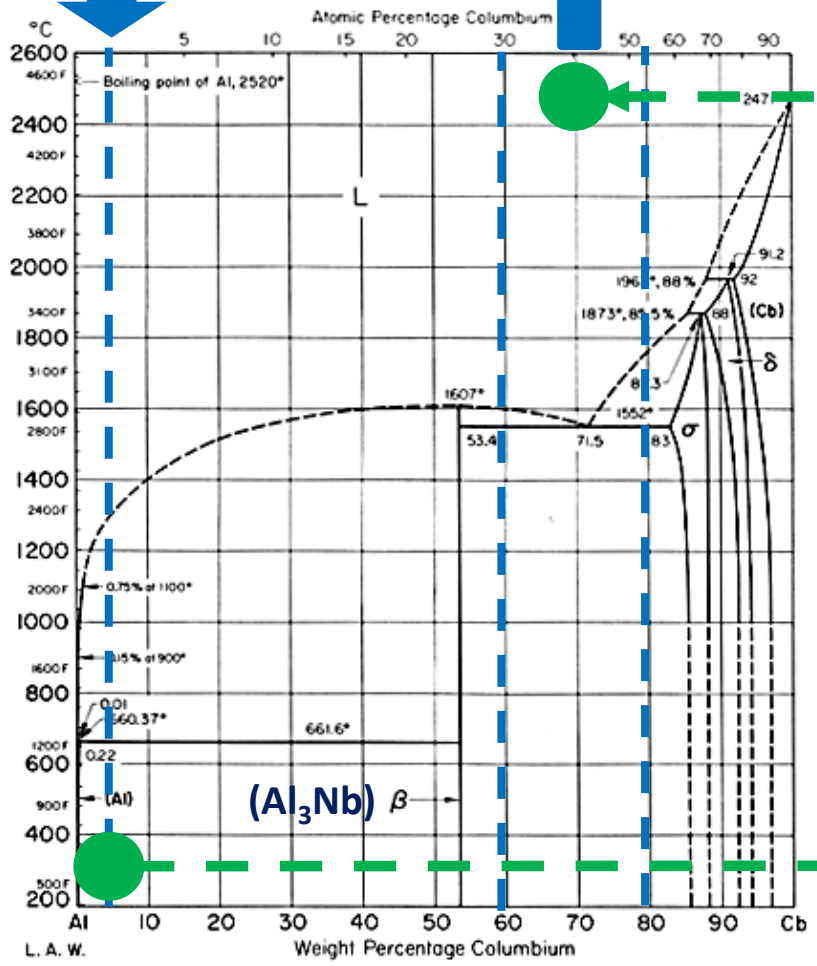
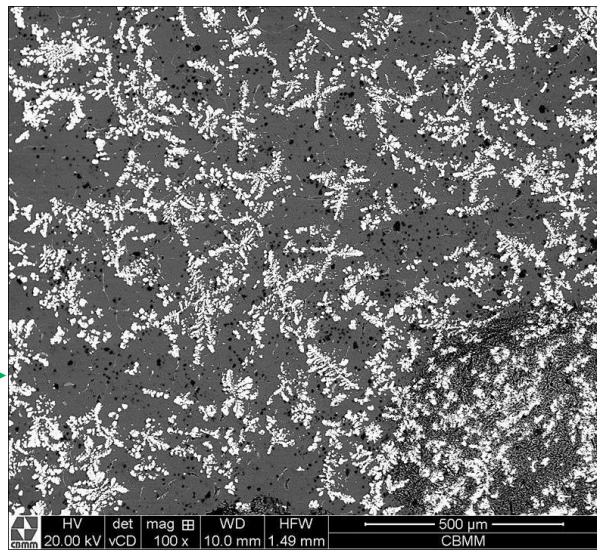
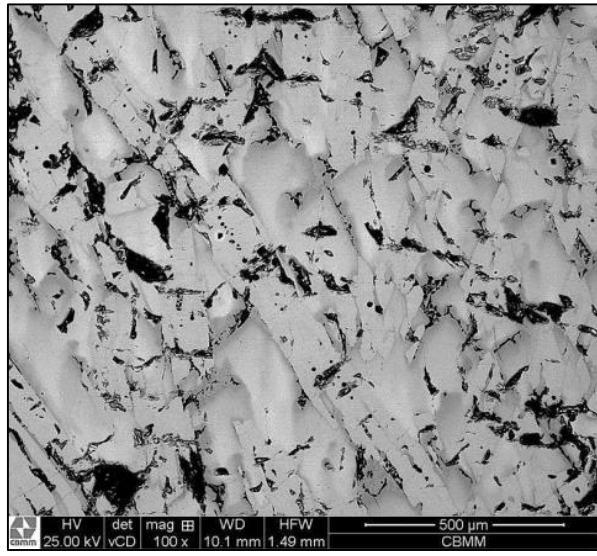
1° S



High Nb alloy

Nb(60-80%)-Al

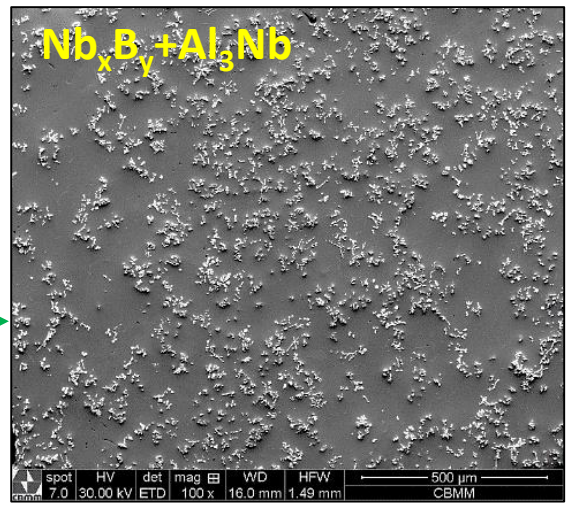
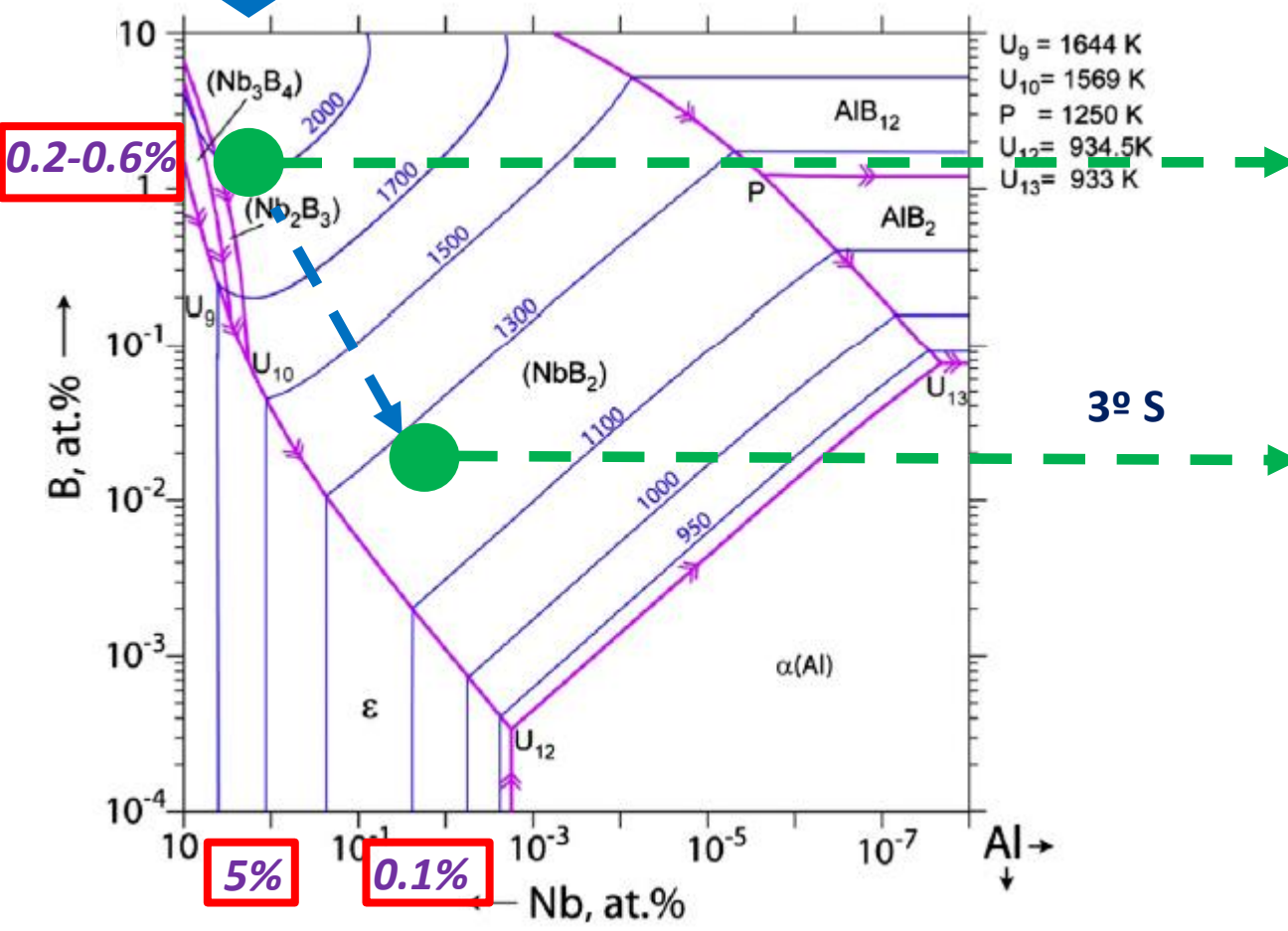
Niobium Metal (Nb°)



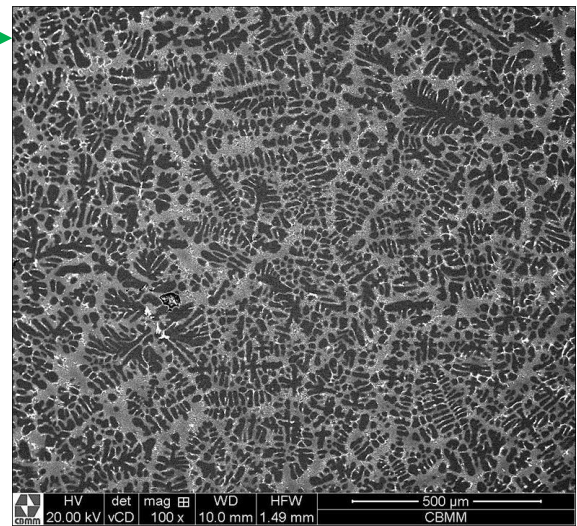
Al-(5%)Nb Master Alloy



NbAl (60-80%Nb) + AlB (4-8%B) = **Al-5Nb-B** 2^o S



Al-5%Nb-0.6%B Master Alloy



Grain Refined Al-Si Alloy

V.T. Witusiewicz et. al, "The Al-B-Nb-Ti system. VI. Experimental studies and thermodynamic modeling of the constituent Al-B-Nb system". *Journal of Alloys and Compounds* 587 (2014) 234-250.



Melting Down



Tapping



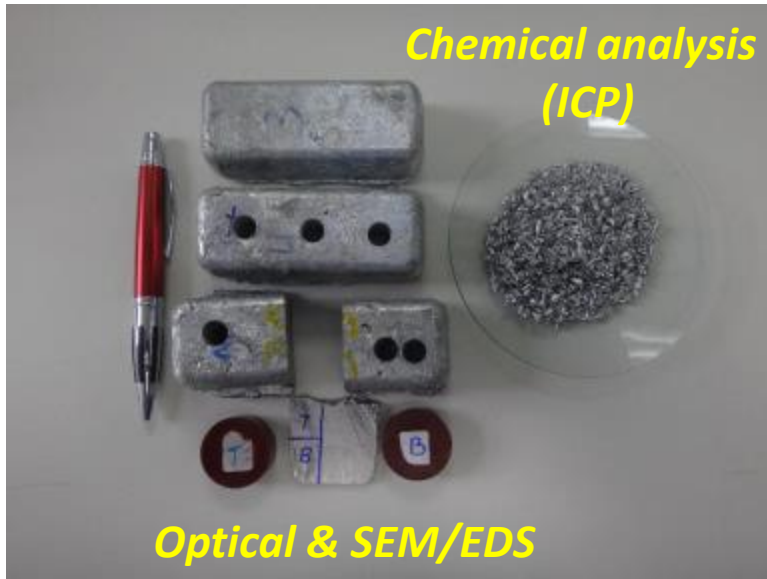
Nb-Al Addition



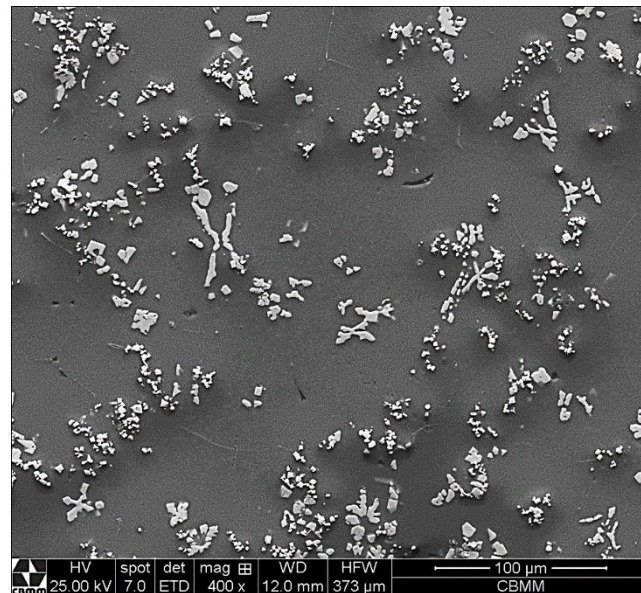
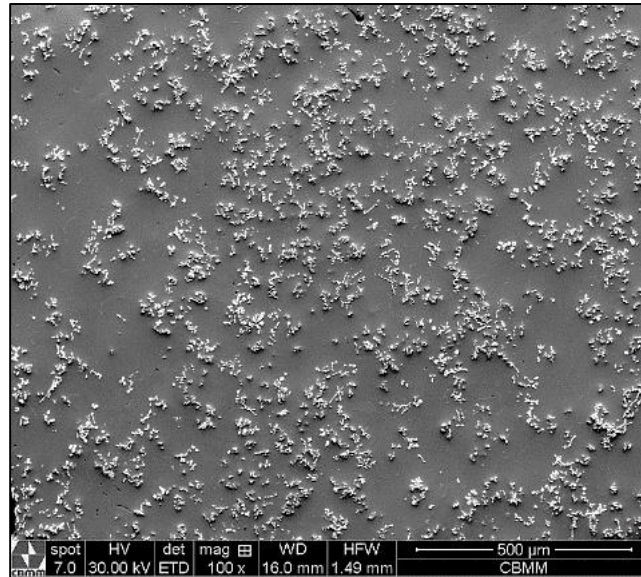
Al-Nb-B Master Alloy Ingot



Chemical analysis
(ICP)

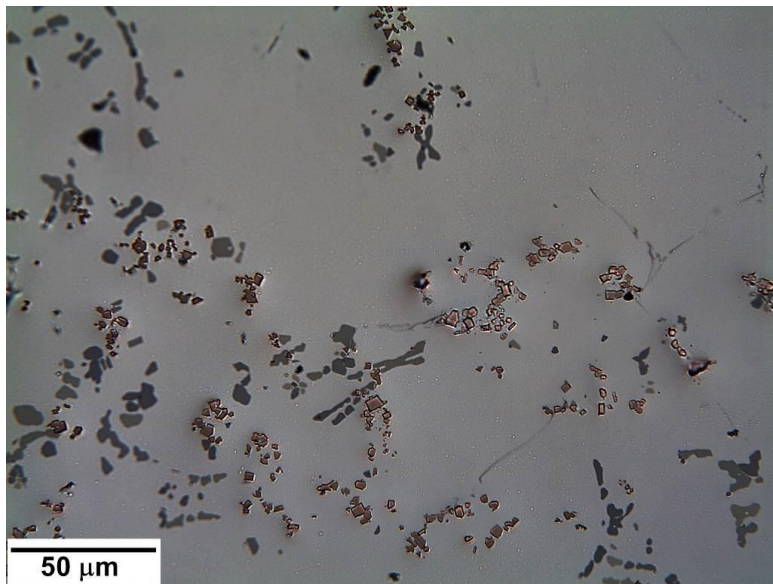


Optical & SEM/EDS

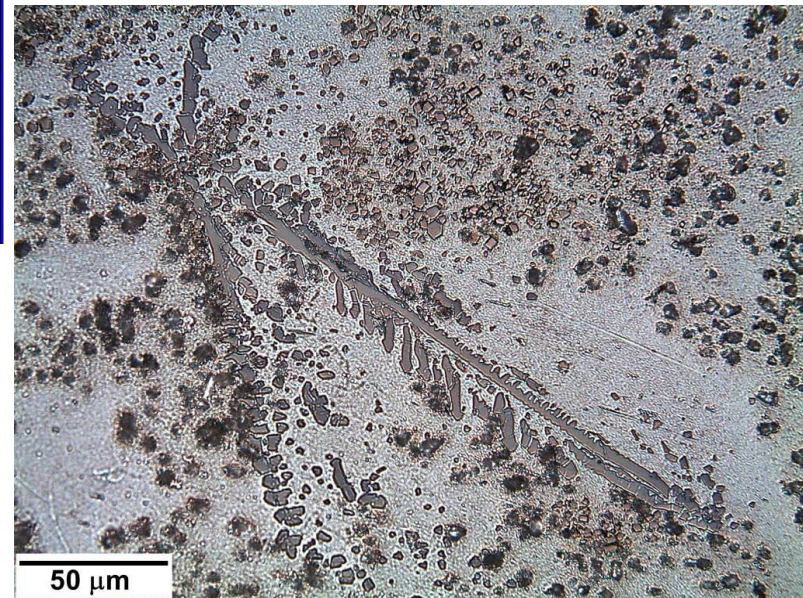
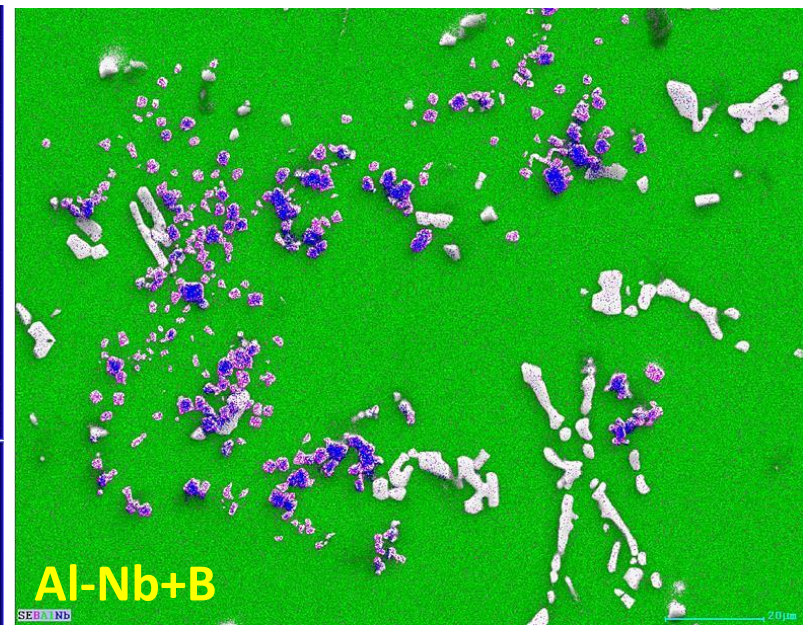
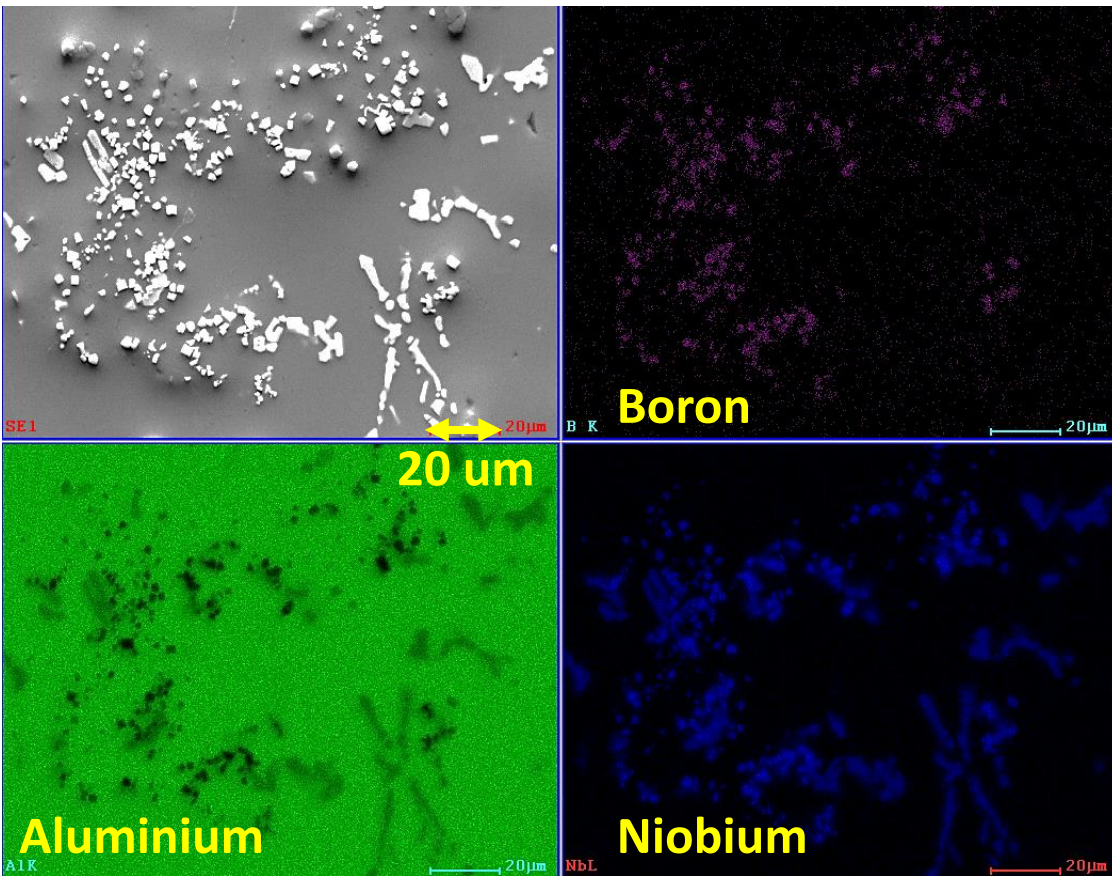


Main
phases:

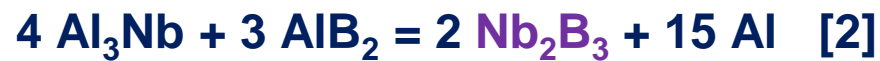
- Al
- Al_3Nb
- AlB_2
- NbB_2
- Nb_2B_3



50 μm



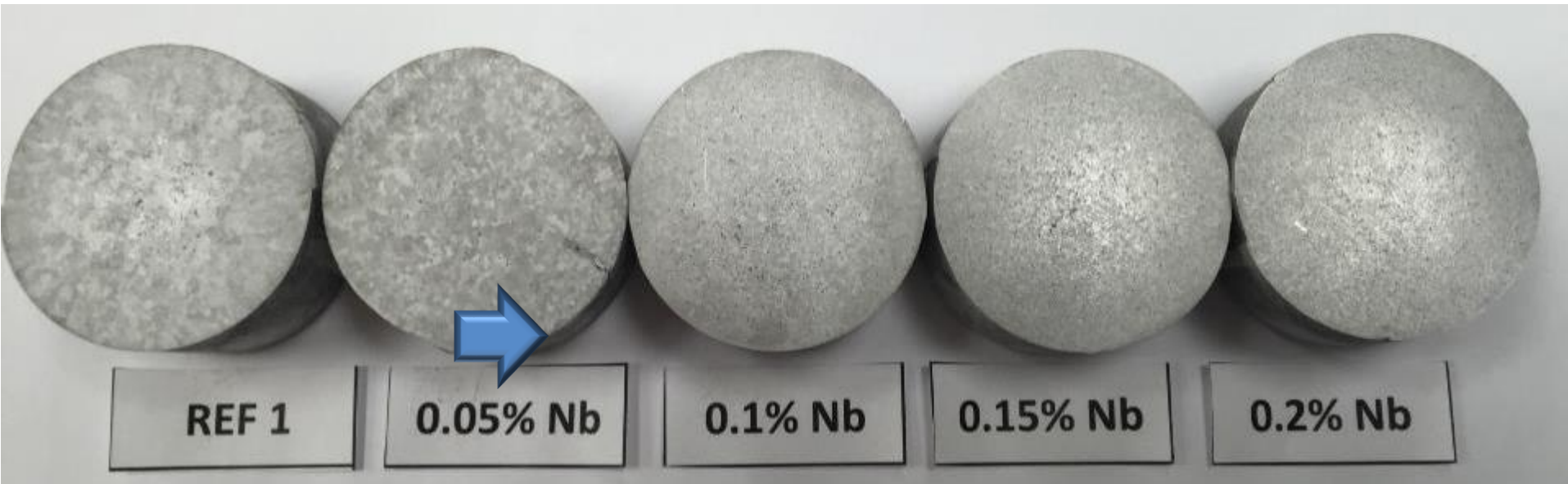
Formation of nucleation sites:



June 2015 e March 2016: Lab scale trials

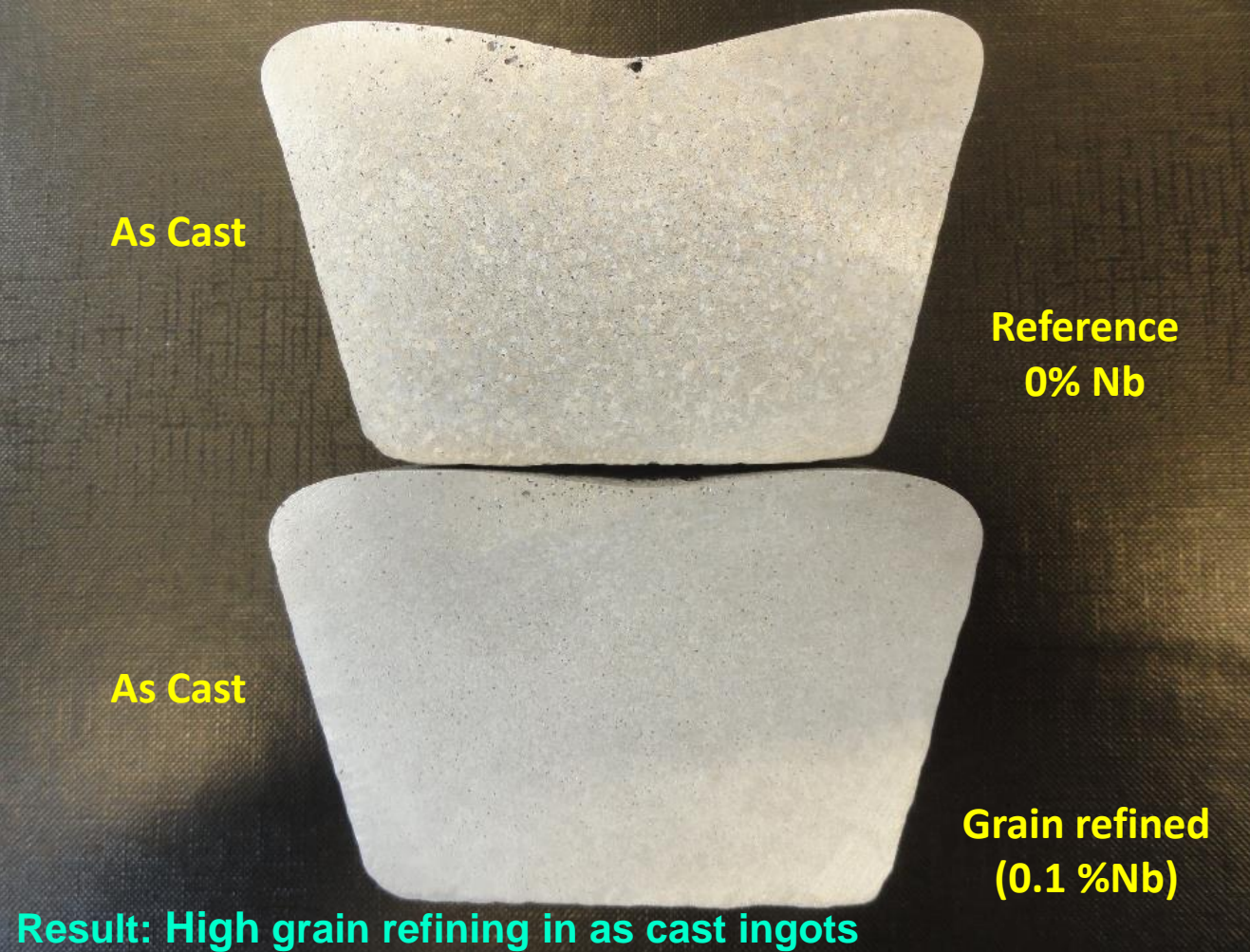


Al-5Nb-B Master Alloy



- **Results:** High grain refining of Al-Si alloys for Nb \geq 0.05wt%
- **Decision:** Validate the industrial application of the grain refiner

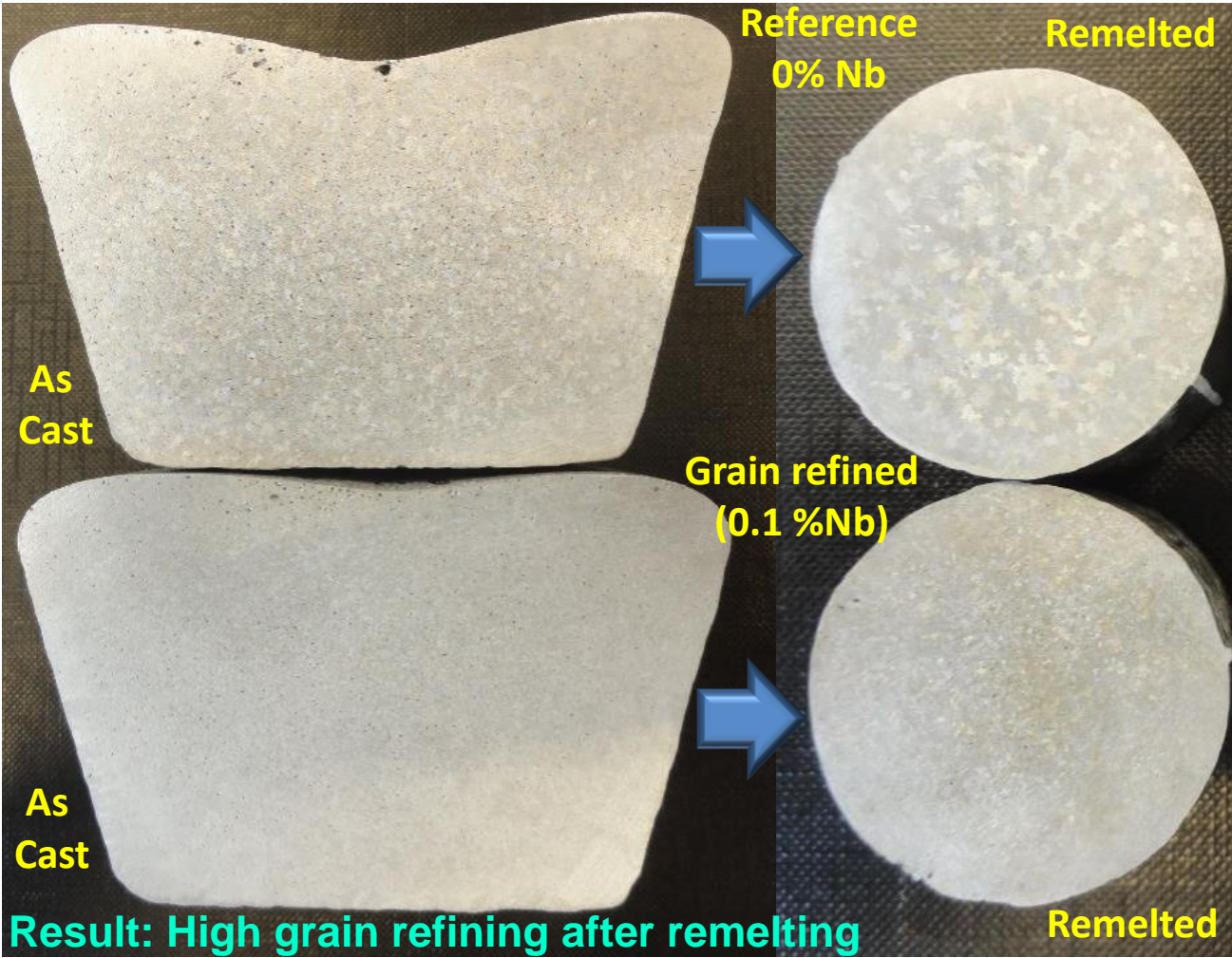
May 2016: 1st Industrial validation trial



May 2016: 2nd Industrial validation trial



&



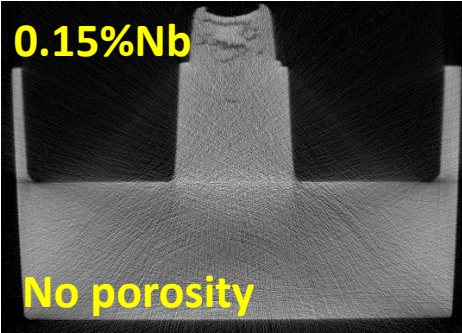
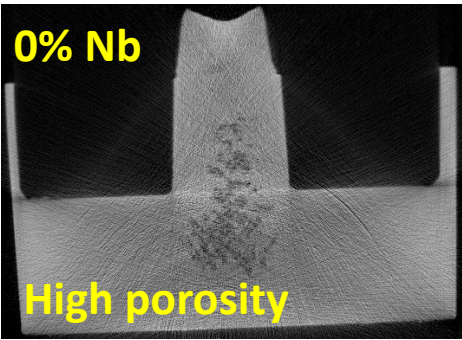
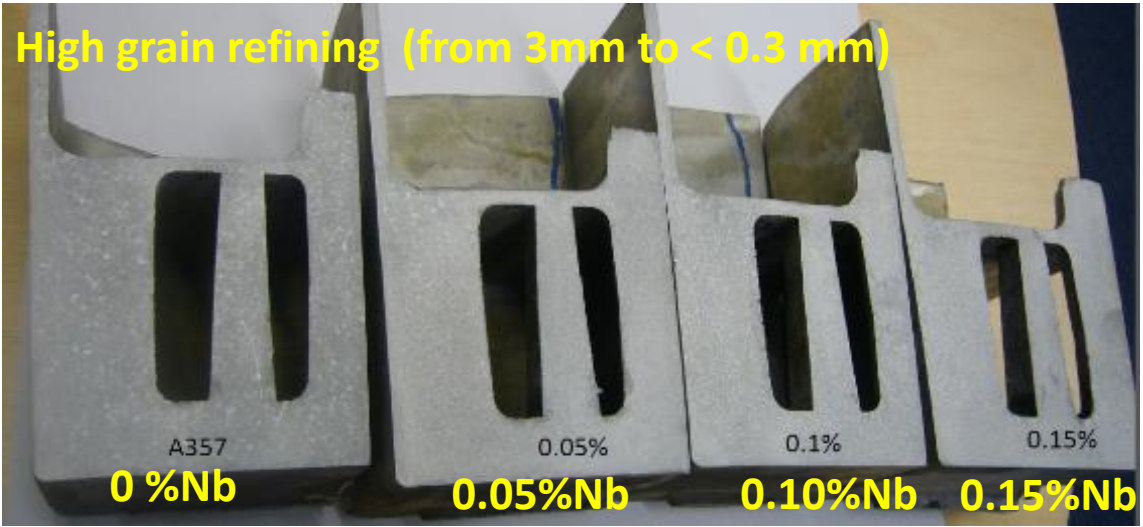
May & June 2016: 3rd Industrial validation trials



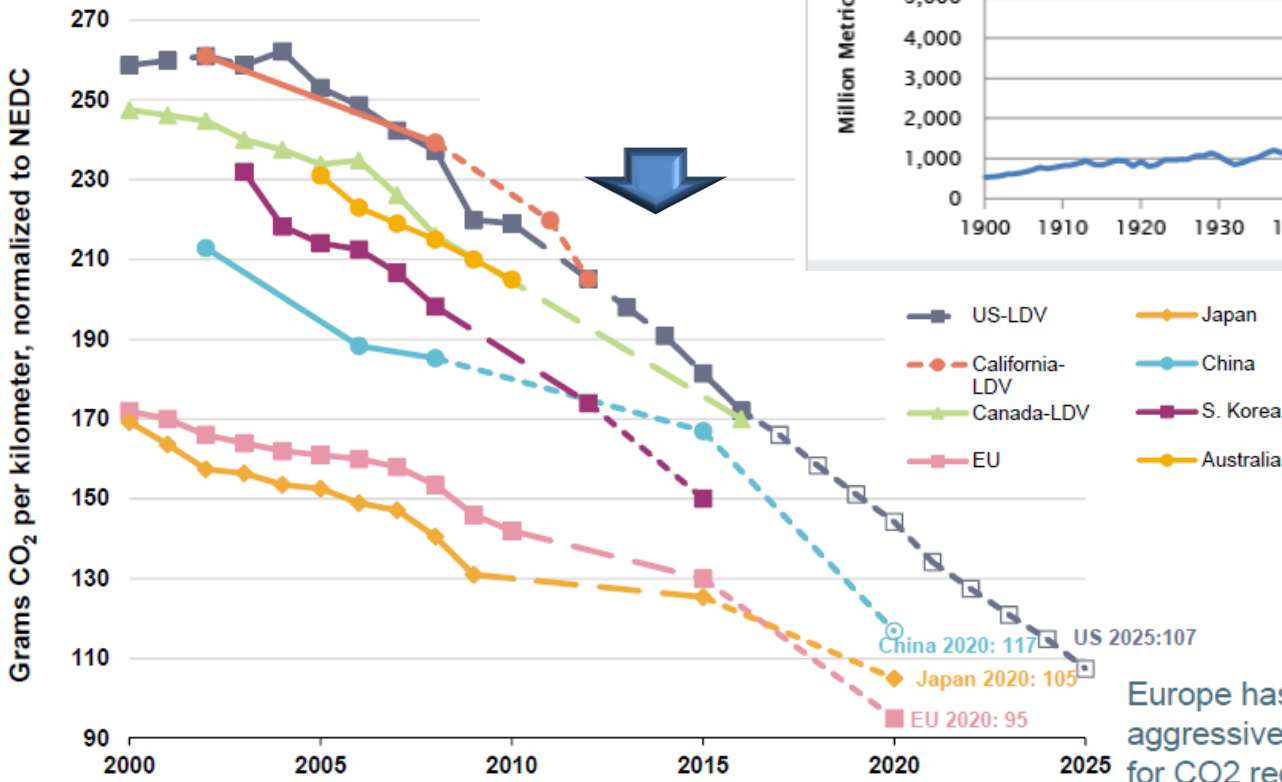
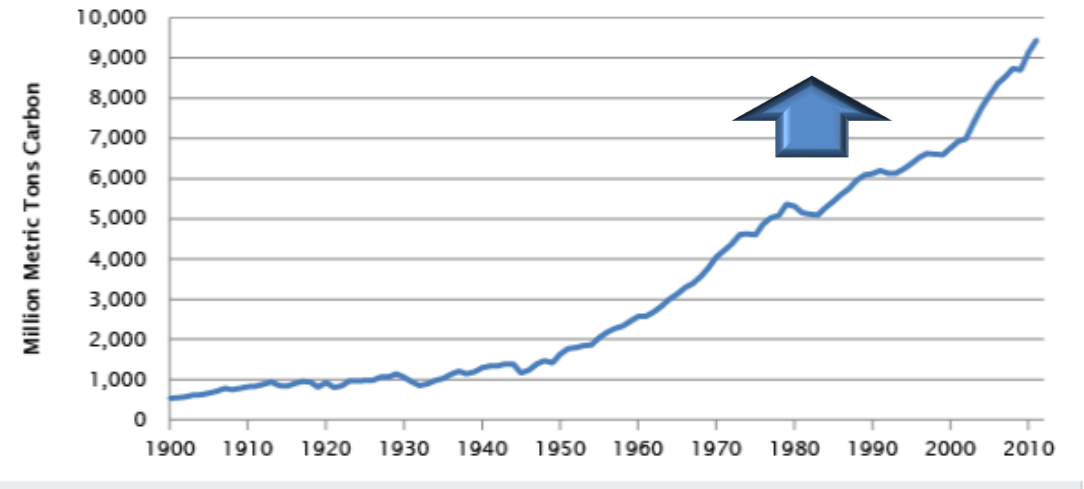
Brunel University London



GRAINGER & WORRALL



Global Carbon Emissions from Fossil-fuels 1900-2011



Starting last August 2015, Beijing imposed restrictions on car use and factory production.

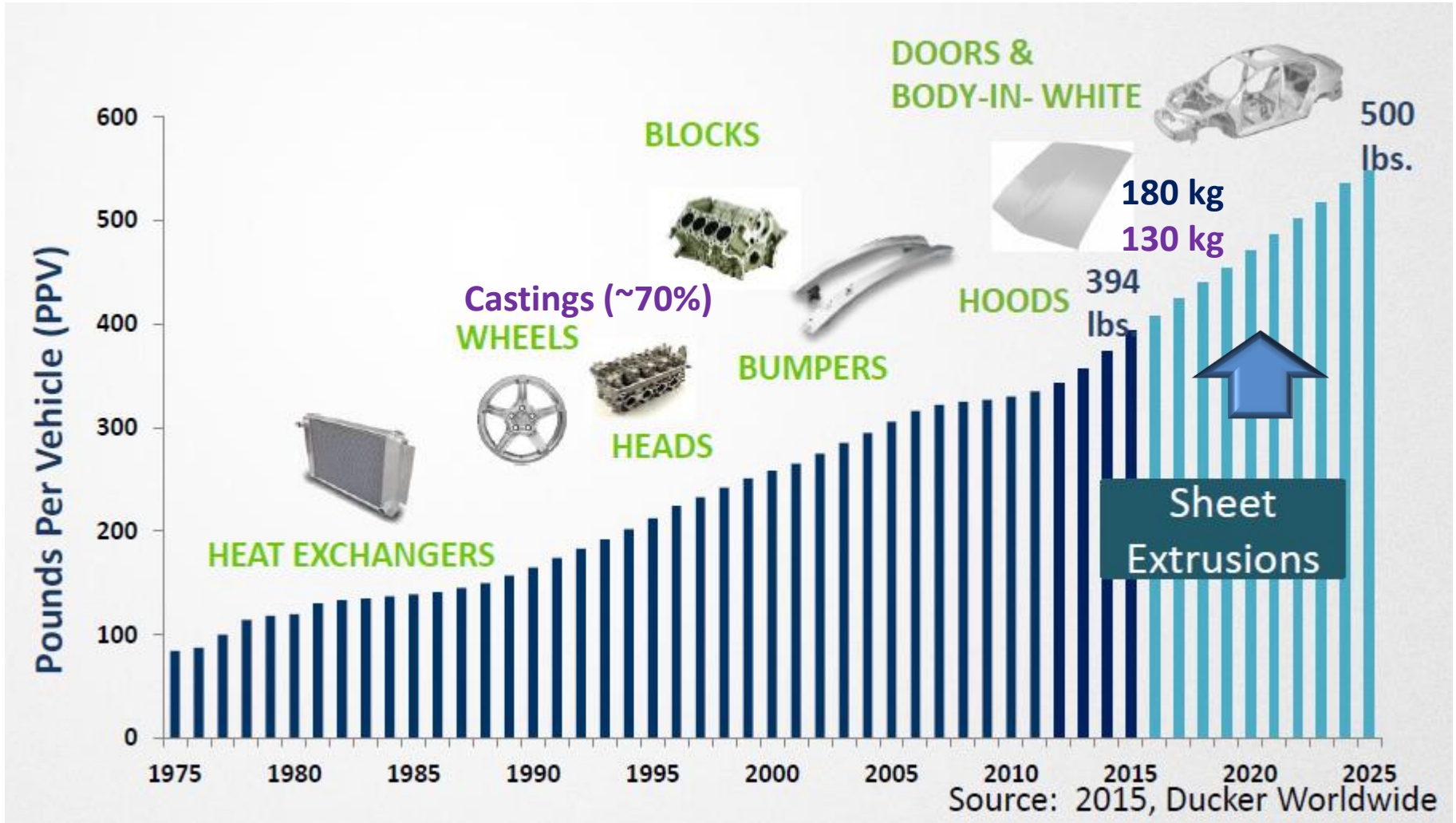


Photo credit: The Guardian

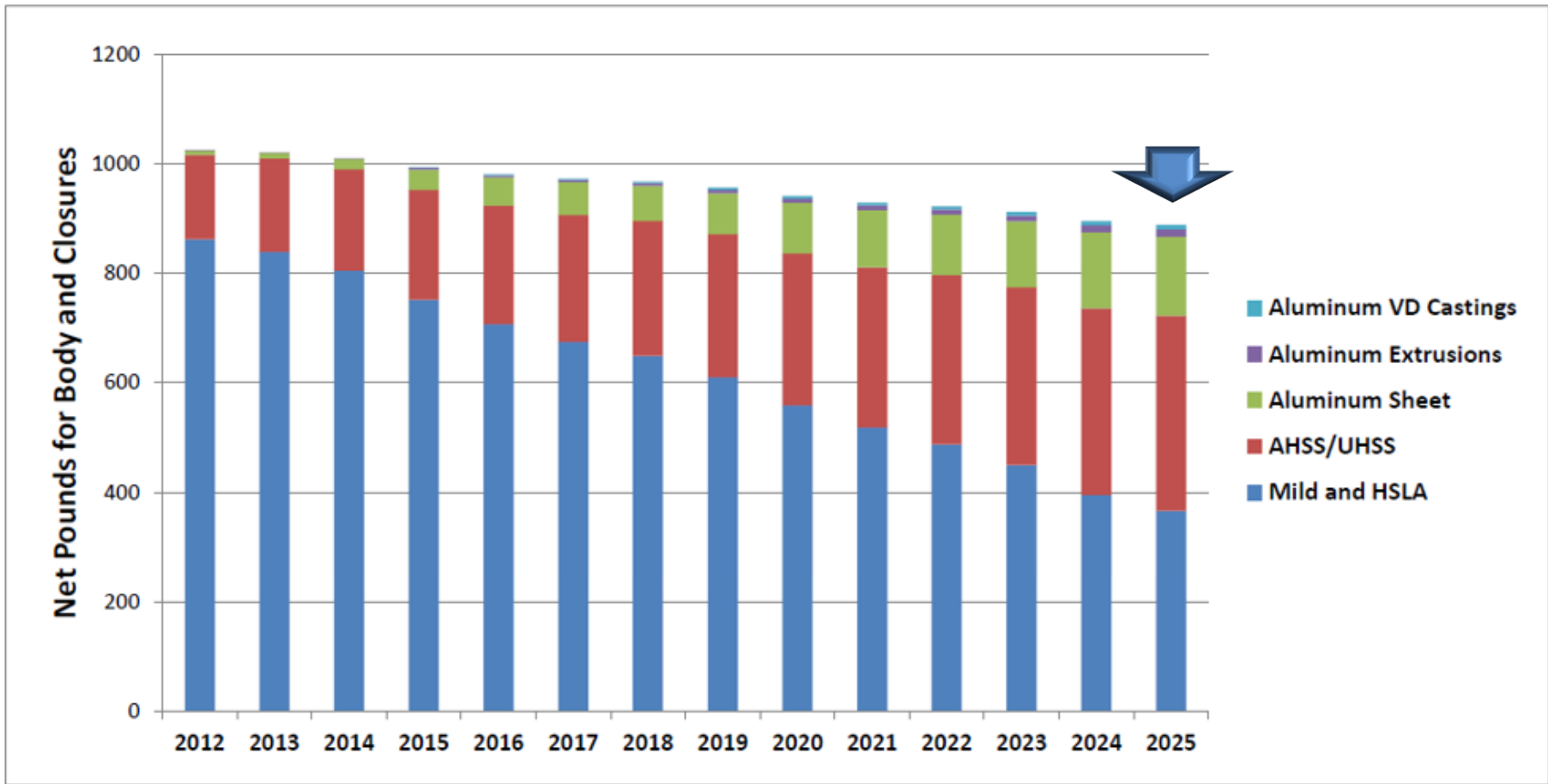
Europe has very aggressive targets for CO2 reduction

Automotive

50 years of growth in the North American automotive market



Joe Quinn, The Aluminum Association: "The auto opportunity: North American market trends" 7th International Aluminum Congress and ExpoAlumínio, São Paulo, Brazil, June 8 2016.



DUCKER WORLDWIDE

Niobium Microalloyed Steel + Niobium Grain Refined Aluminum Alloys for a sustainable world



Thank you!

