

Aluminum Recycling in a Carbon Constrained World: Observations and Opportunities



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The Aluminum Industry - Perspectives on our Future

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Chief Seattle (1788-1866)



**“ We didn’t inherit the earth from our parents.
We are borrowing it from our children.”**



Global Metals Industry

(Million Metric Tonnes)

<u>Metals</u>	<u>World Production (2008)</u>	<u>CO2E (T/T)</u>	<u>% Global GHG</u>
Iron & Steel	1,330	1.0	>4
Aluminum	35	14	>1
Copper	17	5.5	<1
Zinc	10	3	<<1
Magnesium	1	> 18	<<1
Titanium	0.1	> 20	<<1



Impact of Aluminum Industry on GHG

Aluminum is responsible for > 1% of global human induced greenhouse gases (Carbon Dioxide and Perfluoro Carbons)

Carbon Dioxide (CO₂)

10 kg CO₂ per kg of primary aluminum production (35 million tonnes)
350 million metric tonnes CO₂ per year for primary production

0.5 kg CO₂ per kg of aluminum remelted or recycled (30 million tonnes)
15 million metric tonnes CO₂ per year for recycled production

Perfluoro Carbons (PFC)

1.0 kg PFC per tonne of aluminum production
Equivalent to 250 million metric tonnes of CO₂

Recycle to reduce the Al industry GHG



Solution Spectrum

1. Engineering : Design and Process for Recyclability
2. Communications : Public, Consumer, Customer, Suppliers
3. Legislative : Local , National, Regional and International
4. Sustainability : Social Responsibility



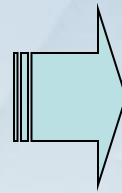
Engineering Solutions

- **Design, Produce and Promote Recycle-Friendly Alloys :**
“Lean & Green “ Products
Alloying Element (Mg, Cu, Si, Mn , Zn...) have even higher carbon foot prints
- **Avoid Unsustainable Alloys / Product Differentiation**
- **Design Multi-Materials Systems for Disassembly**
(Aluminum / Steel / Vinyl / Composites)
- **Broaden Commercialize Use of Sensor- Based Sorting Technologies**



Develop and Utilize More Recycle Friendly Aluminum Alloys

Existing Model
“Primary World”



New Model
“Secondary World”



Product/ Alloy Differentiation

Excessive Product Differentiation Leads to Waste /Cost /Higher Carbon Footprints

57 Varieties of Ketchups

31 Varieties of Ice Creams

>> 1000 Varieties of Coffees / Wines

> 100 Aluminum Alloys in Commercial Use



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Recycle Friendly Alloys (RFA)

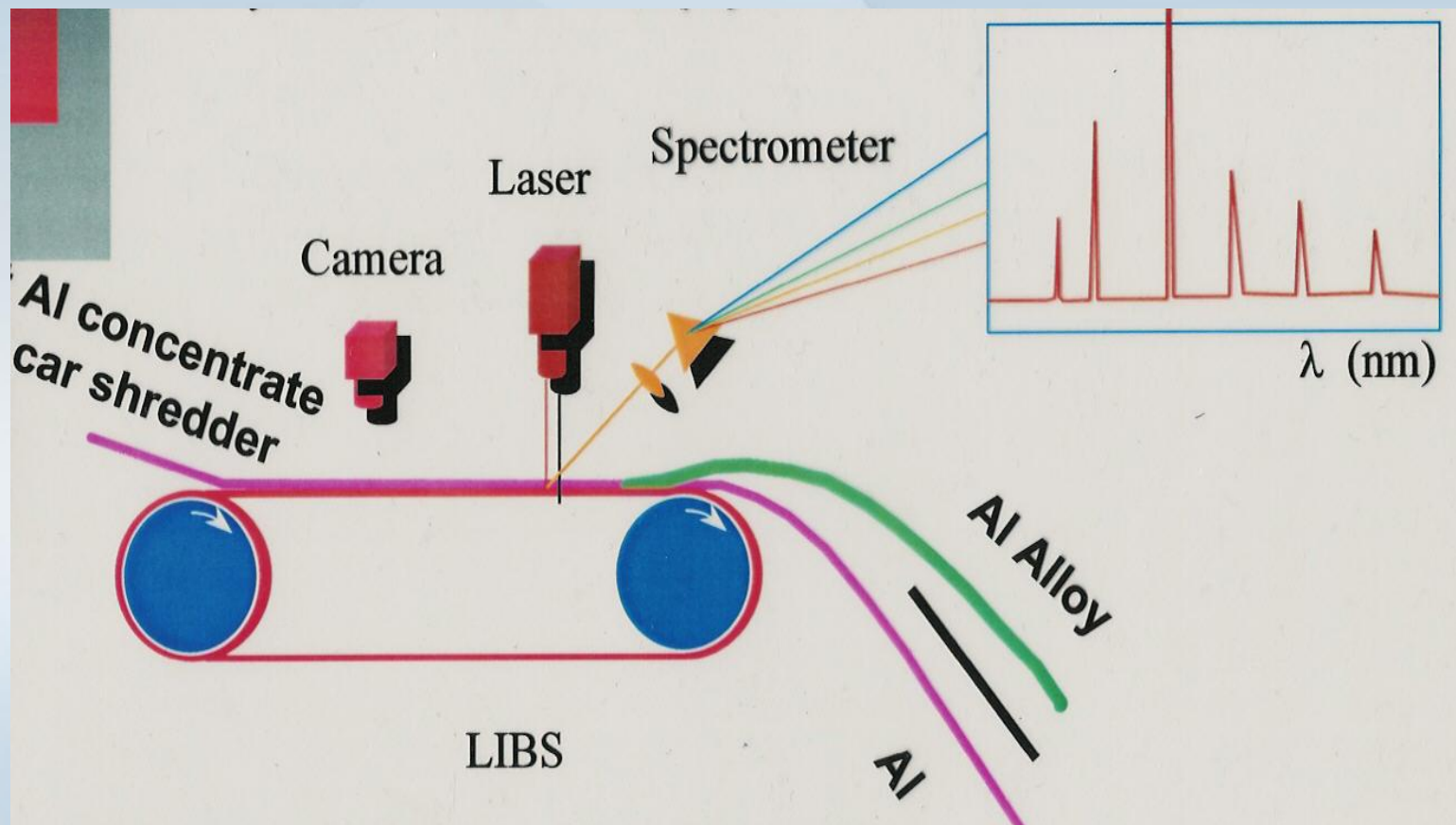
15 RFA : “Lean and Green”

Electrical	1350
Can Sheet	3104 for Body , Lids and Tabs
B&C	3105 (painted sheet) , 6061 (Extrusion)
Automotive	5754 (inner) , 6111-T4 (outers) 6061-T6 (bumpers/structural) , A356 , 380 , 319
Aerospace	2024 , 7075 (plate, extrusion)
Marine	5052 (sheet) , 6063 (extrusion)
Material / Metallurgical Engineers :	Stay away from the “ <u>Periodic Table</u> ” as “ Entropy” Toys -- Li, Ag ,Be, Bi, Pb, Ti ,Cr, Zr, V

All we need is Cu, Zn, Mg, Mn ,Fe and Si



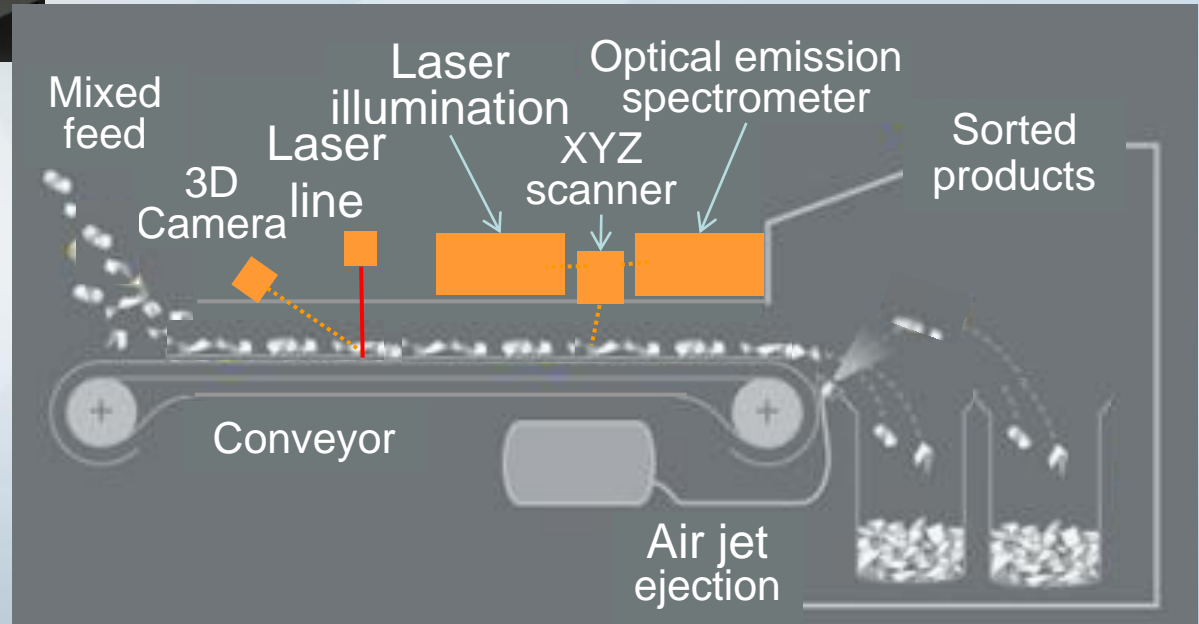
Sensor Based Particle Sorter



TiTech LIBS elemental concentration sensor sorter



Alloy sort or batch
based on analysis of
all major alloying elements,
light and dense



AI scrap and laser line illumination for the 3D sensor



Communications Solutions

Recycling Consumes 5 % of the Energy ? : Revalidate

Recycling Rate is 54% ? : Consolidate Methodologies

All Material are Claimed “Green” and “Recyclable”

Refine and Promote Adoption of Recycling Indices

Aluminum Recycling Index (ARI)

Recycling Production Index (RPI)

Define Common LCA Methodologies for Competing Materials



Alloy Recycling Index (ARI) Recycling Production Index(RPI)

- **ARI – Recyclability for recovering the maximum stored energy invested in the alloy and carbon footprint (Quantative) :**
0 - 100
- **RPI – Ease of producing from recycled remelts (Qualitative) :**
Low (L) , Medium (M) , High (H) , Unusable (U)



ARI & RPI for Key Aerospace Alloys

<u>ALLOYS</u>	<u>ARI</u>	<u>RPI</u>
• 2XXX	94	M
• 7XXX	91	M/L
• 2XXX/7XXX	91	U

As compared to more recycle friendly alloys

• 3XXX , 6XXX	98	H
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Legislative Solutions

1. Promote Bottle / Deposit Bill
2. Develop/Implement Protocols for Qualifying Recycling as Carbon Credits/Offsets
3. Meet & Promote Voluntary Commitments (EPA Climate Leadership Programs)



Sustainability – Social Responsibility -1

Produce Alloys & Products with Multiple Attributes and Recyclability

May Not Have Enough Primary Aluminum for ALL PRODUCTS for >> 7 Billion People

*** Automotive : Lightweight (++) , Attribute (+) , high recyclability (+)

** Aerospace : Lightweight (++) , Performance (++) , Recyclability (-)

* Packaging : Convenience (+) , Recyclability (- -)

*** Electrical : Attribute (+) , Cost (++) , Recyclability (-/+)

* B&C : Lightweight (+) , Recyclability (-/+)



Sustainability—Social Responsibility - 2

Packaging

- Curb Value Partnership , Recycle Bank, Habitat for Humanity , Cash for Cans
“No Cans Left Behind “, RFID Tags to Track / Recover Lost Aluminum Products
- Consider Urban Mining of Used Beverage Cans

Aerospace

- Recycle Abandoned Planes from Obsolete “Graveyards”
- Presort 2XXX/7XXX and Use Mixed for Non-Critical Applications

Automotive

- Dismantle / Segregate Components by Alloys Before Remelting
- Broaden Commercial Use of Sensor Based particle Sorter

B&C

- Sort 5XXX / 6XXX before Recycling from Demolished Buildings



Sustainability—Social Responsibility - 3

Shipping of NA / EU metal scrap to Asia

Takes raw materials away from NA / EU

Transfers GHG emission reductions

Sensor-based sorters can now batch alloys on line – a task that is not possible by hand sorting

Lower trade deficits --- cost differential between imported primary and exported scrap >> over \$ 1 Billion per year for US



Sustainability—Social Responsibility - 4

CHALLENGE : MAKE THE GLOBAL ALUMINUM INDUSTRY

“ OPERATIONALLY CARBON NEUTRAL “

- **NEW ALUMUNUM PRODUCED EACH YEAR SHOULD LAST FOR EVER TO BE USED AGAIN AND AGAIN**
- **TOTAL CARBON DIOXIDE EQUIVALENT NEEDED TO PRODUCE ALL GLOBAL NEW ALUMINUM SHOULD BE DECREASED BY INCREASING RECYCLING AND ENERGY EFFICIENCY >>> AMOUNT LOST BY NOT RECYCLING ALL NEW ALUMNUM PRODUCTS PRODUCED**



Chief Seattle Das (1947-)



“ We didn’t inherit the aluminum from our parents .
We are borrowing it from our children.”

