Introducción

0185 Metalurgia de aleaciones coladas base aluminio

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ALUMINIO MATERIAL DEL SIGLO XXI

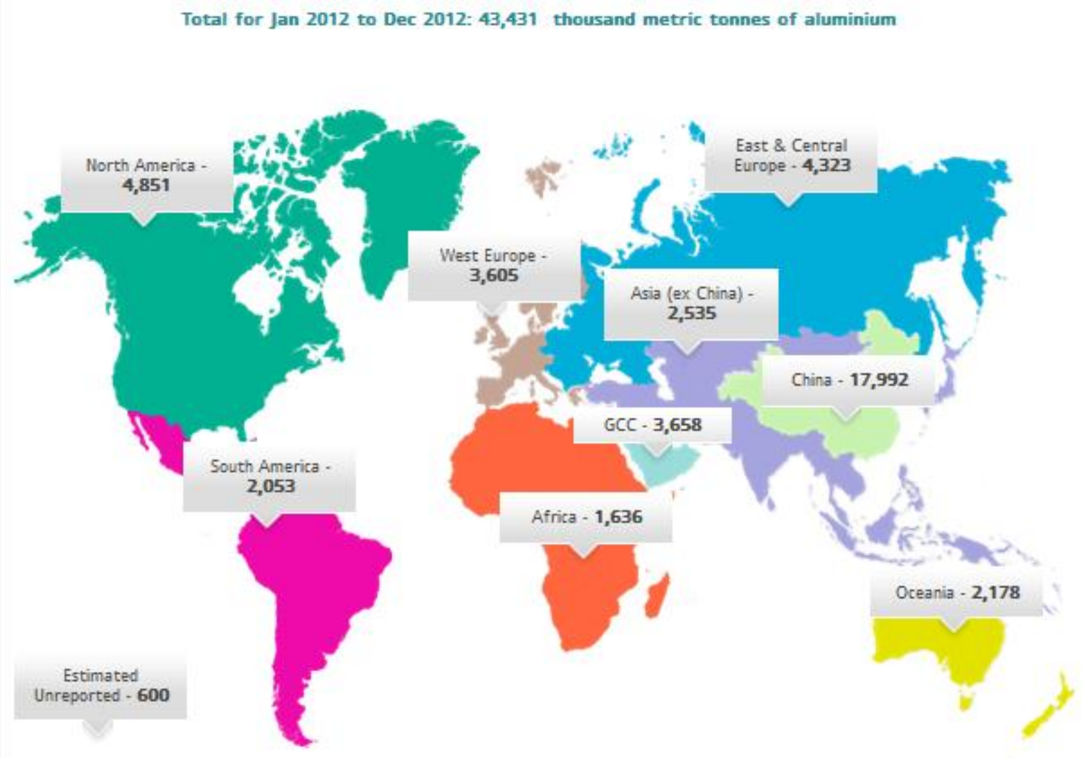
CARACTERÍSTICAS Y PROPIEDADES

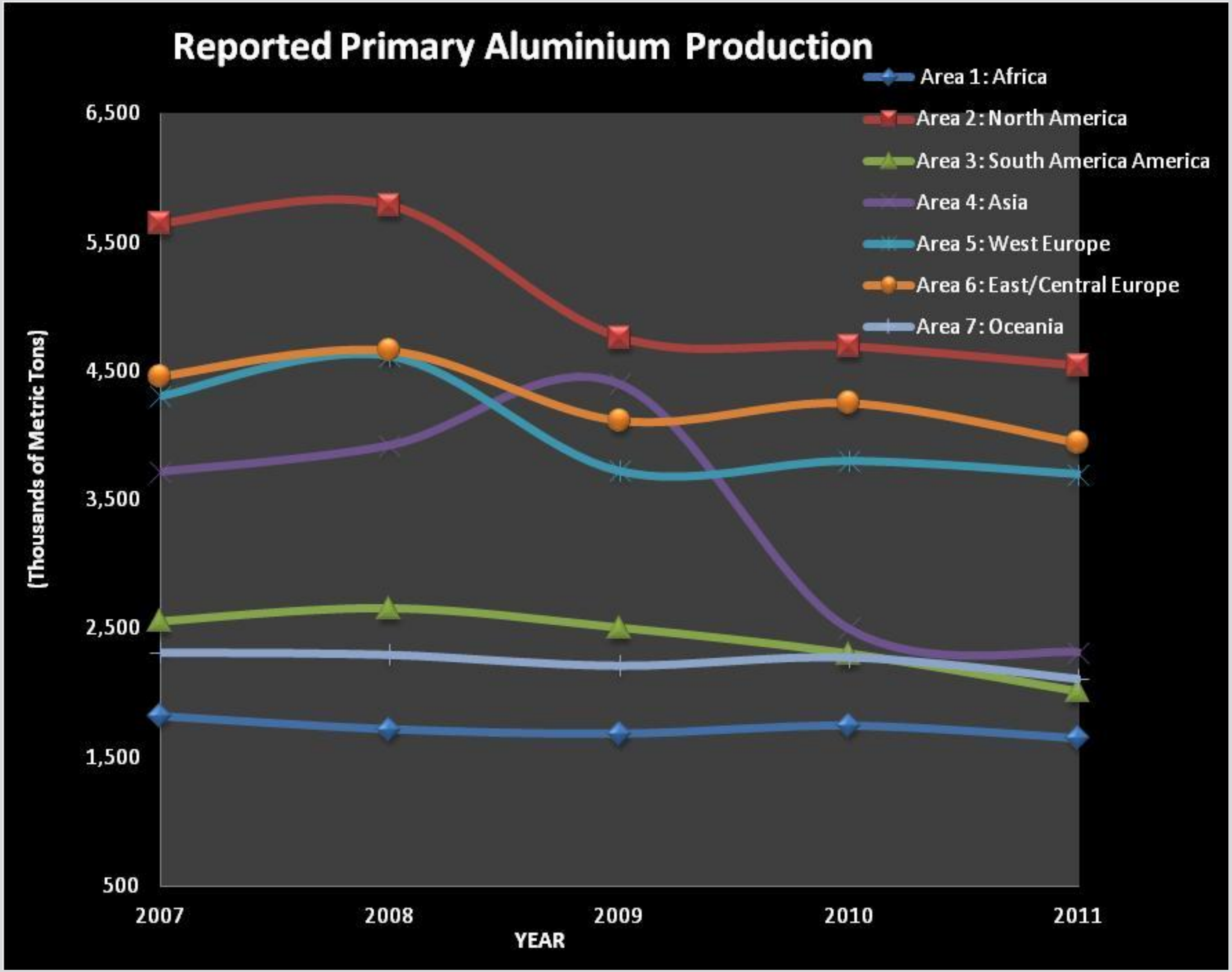
- ✓**Baja densidad, Elevada Resistencia especifica**
- ✓**Alta conductividad: térmica y eléctrica**
- ✓**Buena resistencia a la corrosión**
- ✓**Aspecto agradable (acabado)**
- ✓**Facilidad para alearse**
- ✓**Facilidad para ser procesado: fundirse, maquinarse, soldarse, laminarse, Trat. Térmico.**
- ✓**Altamente Reciclable**
- ✓**Alta fluidez y buenas propiedades de fundición**

Ubicación del sector fundición en la industria del Aluminio

La producción mundial de aluminio primario ha crecido de alrededor de 2 millones de toneladas en 1950 a 39,7 millones de toneladas en 2008. Al igual que en el caso del acero, se han producido cambios drásticos en los principales productores. Por una parte, en los Estados Unidos se ha pasado de poco más del 40 % en 1960 a menos de 7 %. China ha aumentado hasta adquirir una participación del 34 % en 2008. Rusia, el segundo mayor productor, representa el 11 %, y Canadá el 8 %.

La producción mundial de aluminio secundario creció constantemente, pasando de 2,6 millones de toneladas en 1970 a alrededor de 9 millones de toneladas en 2000, alrededor de un 38 %. Desde entonces, sin embargo, se han invertido las tendencias, aun cuando la producción primaria sigue aumentando rápidamente. En 2008, la producción de 6,3 millones de toneladas a partir de chatarra fue equivalente a sólo el 16% de la producción total.



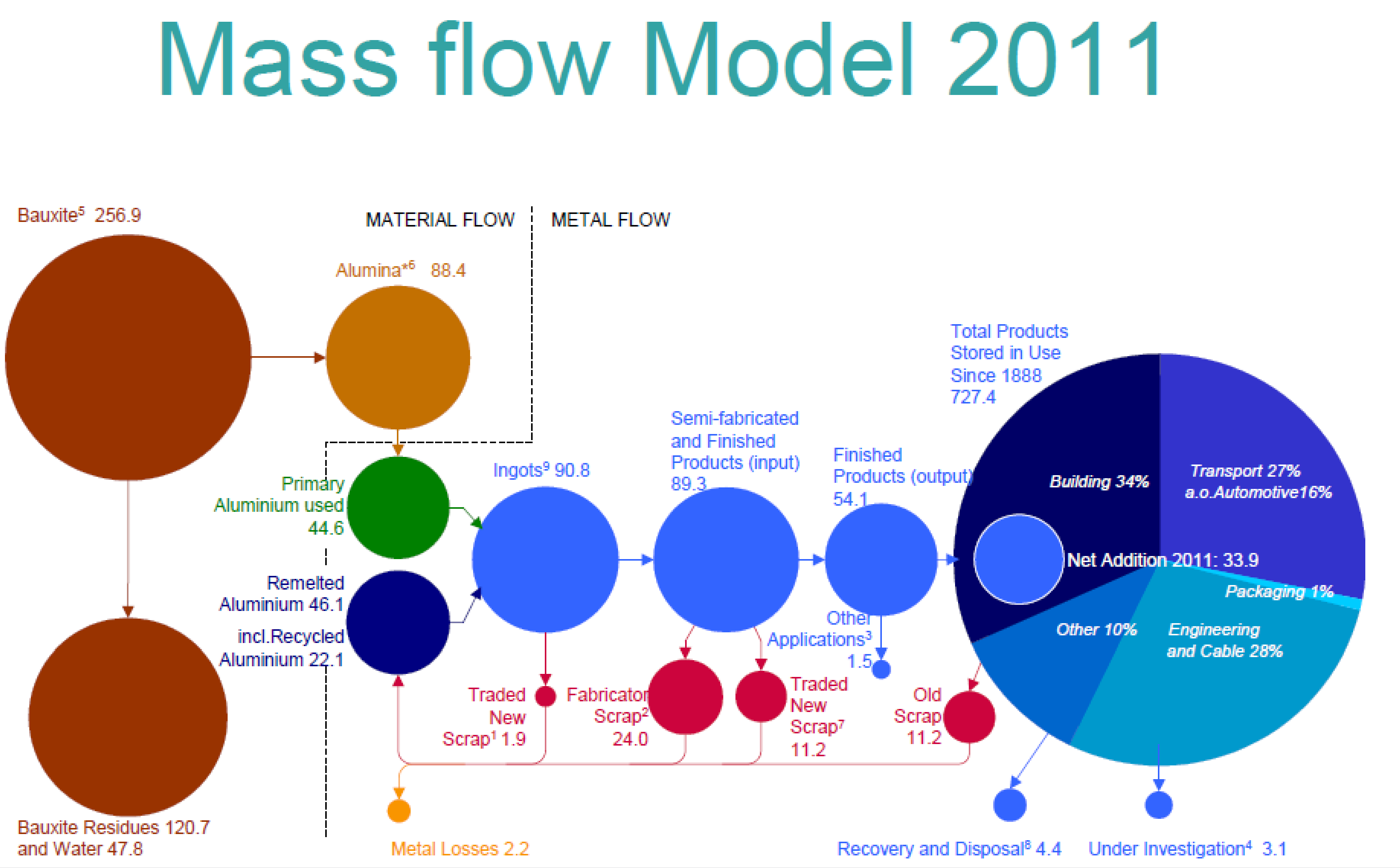


Reported Primary Aluminium Production
Area 1: Africa
Area 2: North America
Area 3: South America America
Area 4: Asia
Area 5: West Europe
Area 6: East/Central Europe
Area 7: Oceania
6,500
5,500
4,500
3,500
2,500
1,500
500
(Thousands of Metric Tons)
2007
2008
2009
2010
2011
YEAR

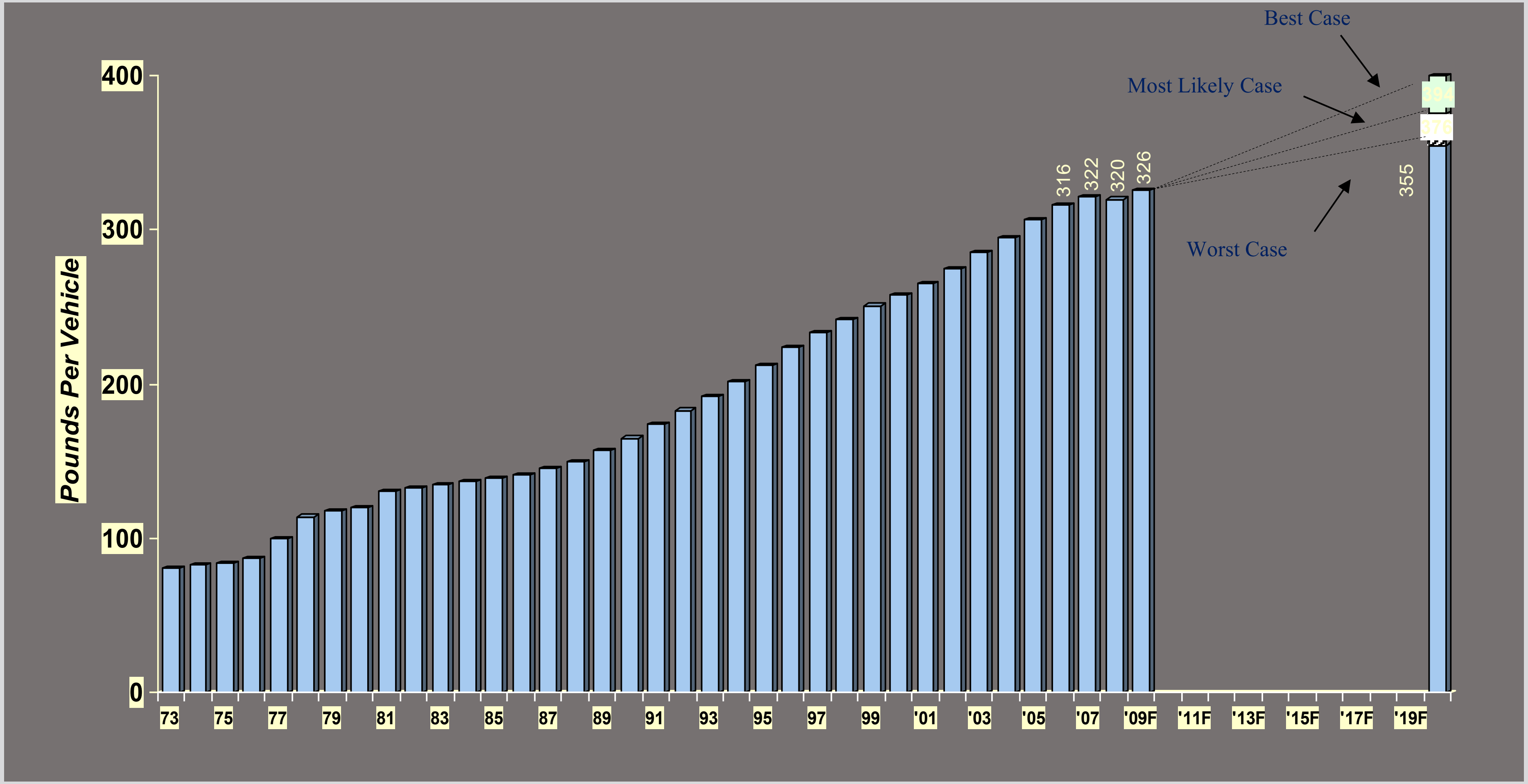
Producción Industrial

PERIOD	AFRICA	ASIA (EX CHINA)	NORTH AMERICA	SOUTH AMERICA	WEST EUROPE	EAST & CENTRAL EUROPE	OCEANIA	GCC	CHINA	EST. UN-REPORTED	TOTAL	DAILY AVERAGE
DEC 2012	150	217	424	170	297	361	176	312	ND	50	2,157	69.6
NOV 2012	144 *	207	408	164	288	349	170 *	301	1,662	50	3,743 *	124.8 *
OCT 2012	142	210	415	172	296	361	175	312	1,717	50	3,850	124.2
SEPT 2012	134	204	393	167	290	350	170	299	1,672	50	3,729	124.3
AUG 2012	141	213	402	173	304	362	182	307	1,749	50	3,883	125.3
JUL 2012	136	213	410	172	304	366	183	304	1,670	50	3,808	122.8
JUN 2012	128	206	397	167	297	355	183	297	1,684	50	3,764	125.5
MAY 2012	131	215	410	173	309	369	189	310	1,678	50	3,834	123.7
APR 2012	125	211	395	173	297	358	183	304	1,531	50	3,627	120.9
MAR 2012	127	219	408	179	314	371	190	310	1,564	50	3,732	120.4
FEB 2012	132	204	382	168	295	348	181	290	1,548	50	3,598	124.1

Consumo de aluminio por sector



A largo plazo el sector automotriz será un mercado de aluminio en crecimiento puesto que los productores buscan maneras de reducir el peso de los autos



Estado Natural

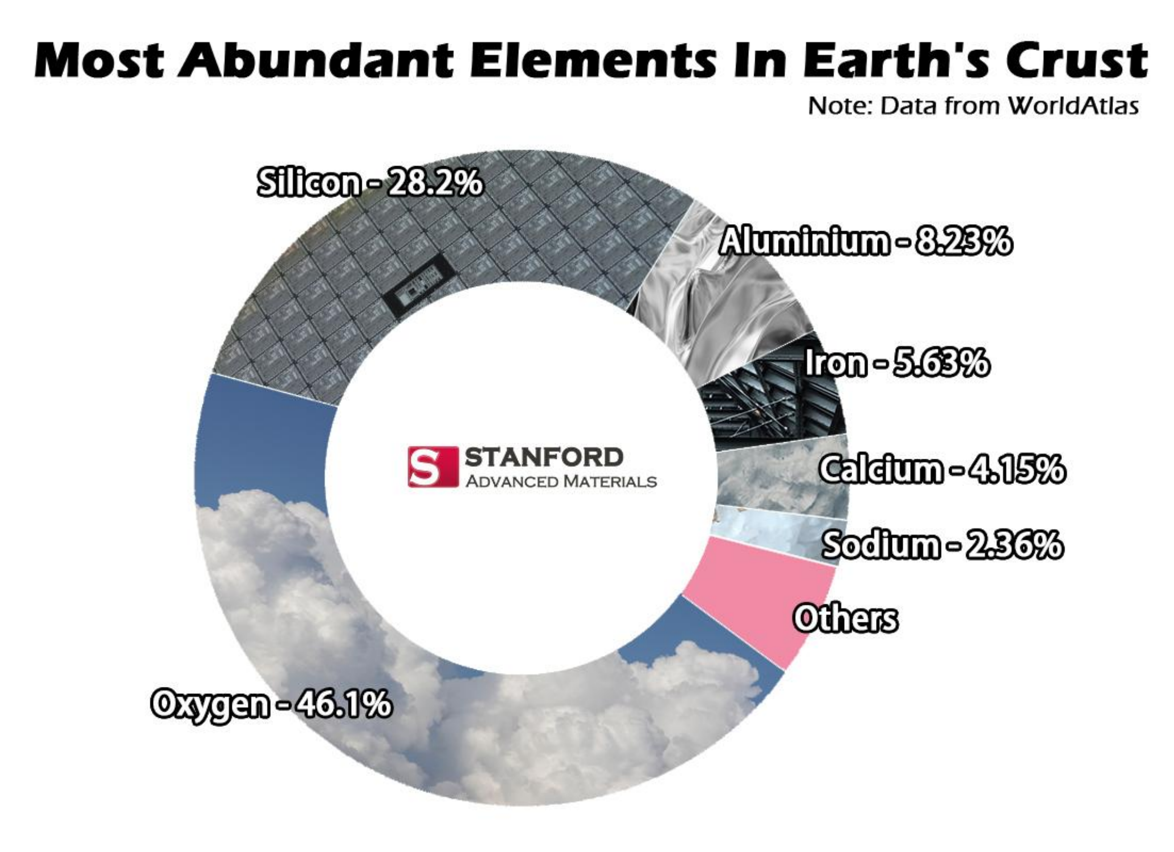
- Oxigeno - Silicio - Aluminio (7.5%)
- Bauxita 50% Al_2O_3

Reseña Histórica del Aluminio

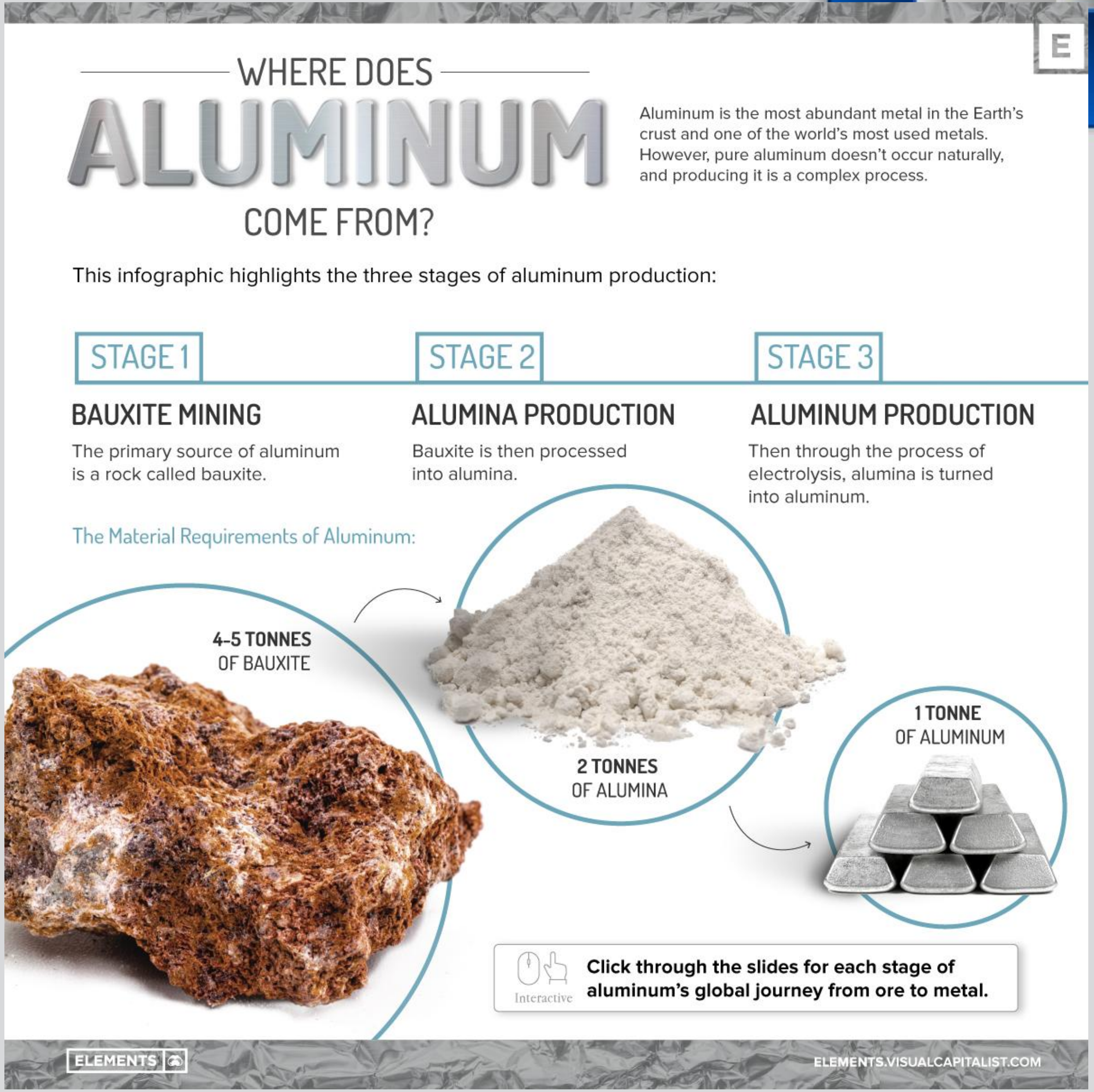
- En 1.821 el Francés Pierre Vertier encuentra en la provincia de Baux una piedra rojiza rica en aluminio a la cual denominaría Bauxita por su lugar de origen.

- 1.854 el Francés Saint Claire Deville presento dos formas de obtención del aluminio a partir de la bauxita una química y otra por electrolisis.

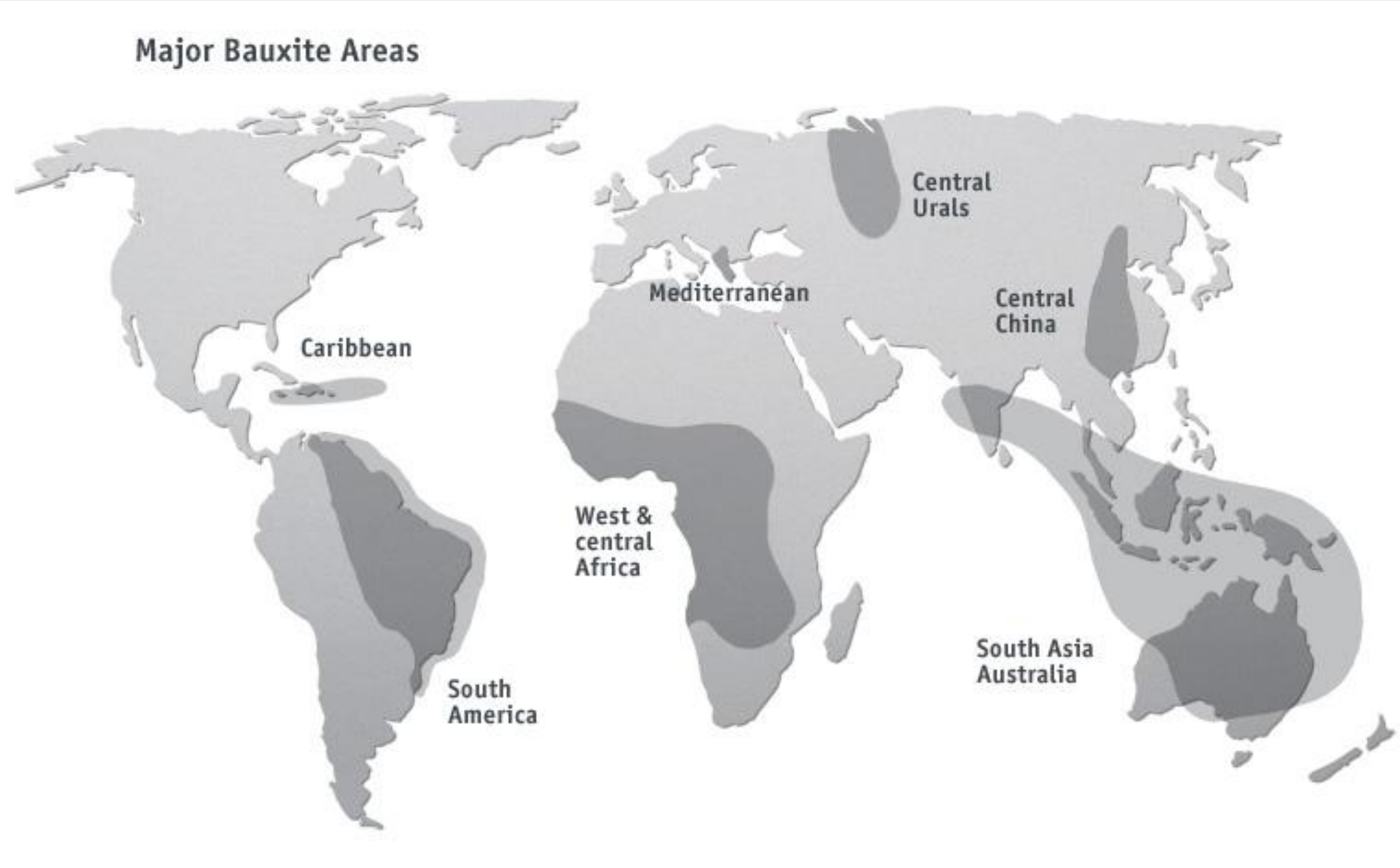
- 1.866 simultáneamente el Francés Paúl Heroult y el americano Charles Martín Hall hallarian el proceso industrial para la obtención del aluminio por medio de la electrolisis.


Most Abundant Elements In Earth's Crust
Note: Data from WorldAtlas
Silicon - 28.2%
Aluminium - 8.23%
Iron - 5.63%
Calcium - 4.15%
Sodium - 2.36%
Others
Oxygen - 46.1%
STANFORD
ADVANCED MATERIALS


Bauxite
$Al_2O_3.2H_2O$
Feldspar
$KAlSi_3O_8$
Corundum
Al_2O_3
Aluminium
Cryolite
Na_3AlF_6
Kaolinite
$Al_2O_3.2SiO_2$
$2H_2O$
Alunite
$KAl_3(SO_4)_2$
$(OH)_6$


WHERE DOES
ALUMINUM
COME FROM?
Aluminum is the most abundant metal in the Earth's crust and one of the world's most used metals. However, pure aluminum doesn't occur naturally, and producing it is a complex process.
This infographic highlights the three stages of aluminum production:
STAGE 1
BAUXITE MINING
The primary source of aluminum is a rock called bauxite.
STAGE 2
ALUMINA PRODUCTION
Bauxite is then processed into alumina.
STAGE 3
ALUMINUM PRODUCTION
Then through the process of electrolysis, alumina is turned into aluminum.
The Material Requirements of Aluminum:
4–5 TONNES OF BAUXITE
2 TONNES OF ALUMINA
1 TONNE OF ALUMINUM
Interactive
Click through the slides for each stage of aluminum's global journey from ore to metal.
ELEMENTS
ELEMENTS.VISUALCAPITALIST.COM

ZONAS CON MINERAL BAUXITA



El mineral de aluminio, conocido comúnmente como bauxita, es abundante y se encuentra principalmente en áreas tropicales y subtropicales: África, India occidental, Sudamérica y Australia. También se encuentran algunos depósitos en Europa. La bauxita se refina hasta obtener alúmina y posteriormente se reduce electrolíticamente en aluminio metálico

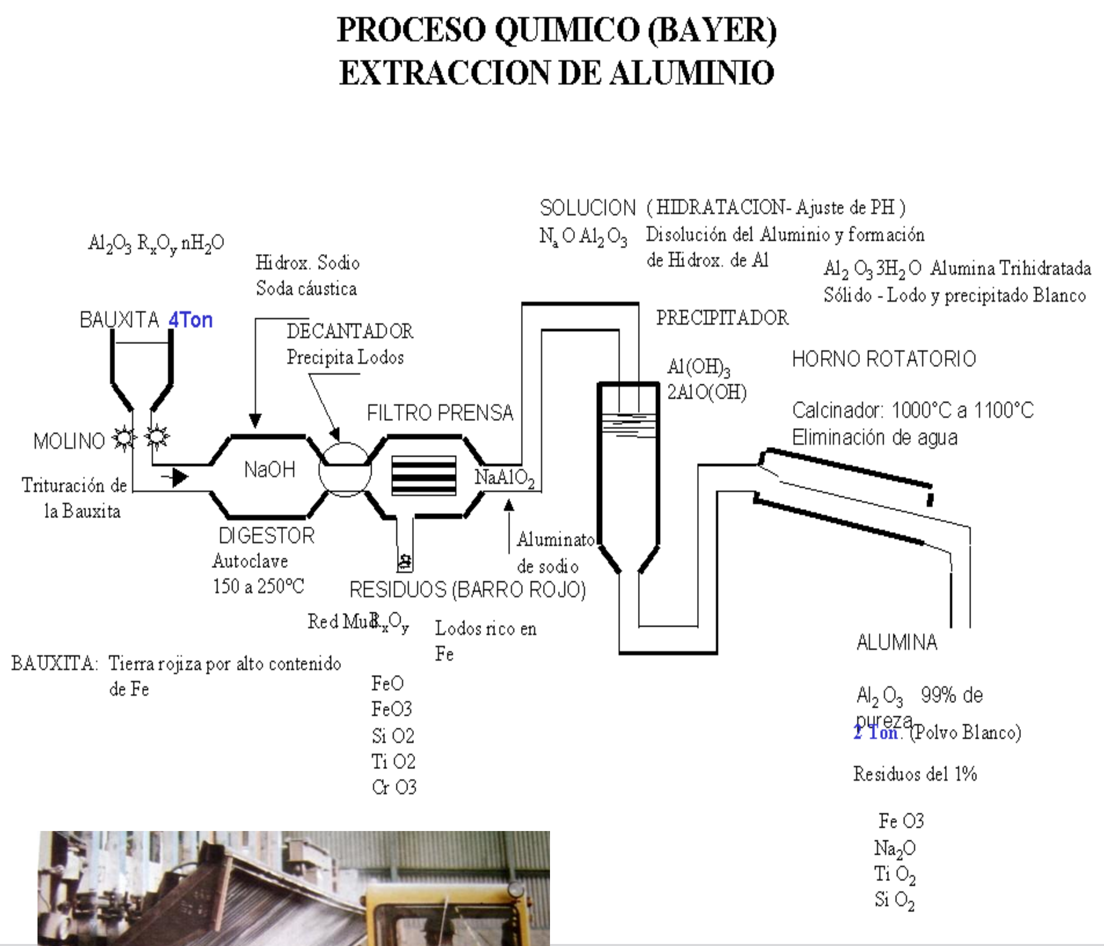
.

La Bauxita

La bauxita es una arcilla de colores blanco, amarillento, exhibe tonalidades rosas a rojas con rayas blancas o rojas.

Dependiendo de la calidad del mineral, se requieren de dos a tres toneladas de bauxita para producir una tonelada de alúmina, y se requieren dos toneladas de alúmina para producir una tonelada de aluminio. Esto quiere decir que se necesitan de 4 a 6 toneladas de mineral para producir una tonelada de metal

Proceso Químico



La bauxita se lava, se sedimenta y se disuelve en hidróxido de sodio (soda cáustica) a alta temperatura y presión.

El líquido resultante contiene una solución de aluminato de sodio y residuos sin disolver que contienen hierro, silicio y titanio.

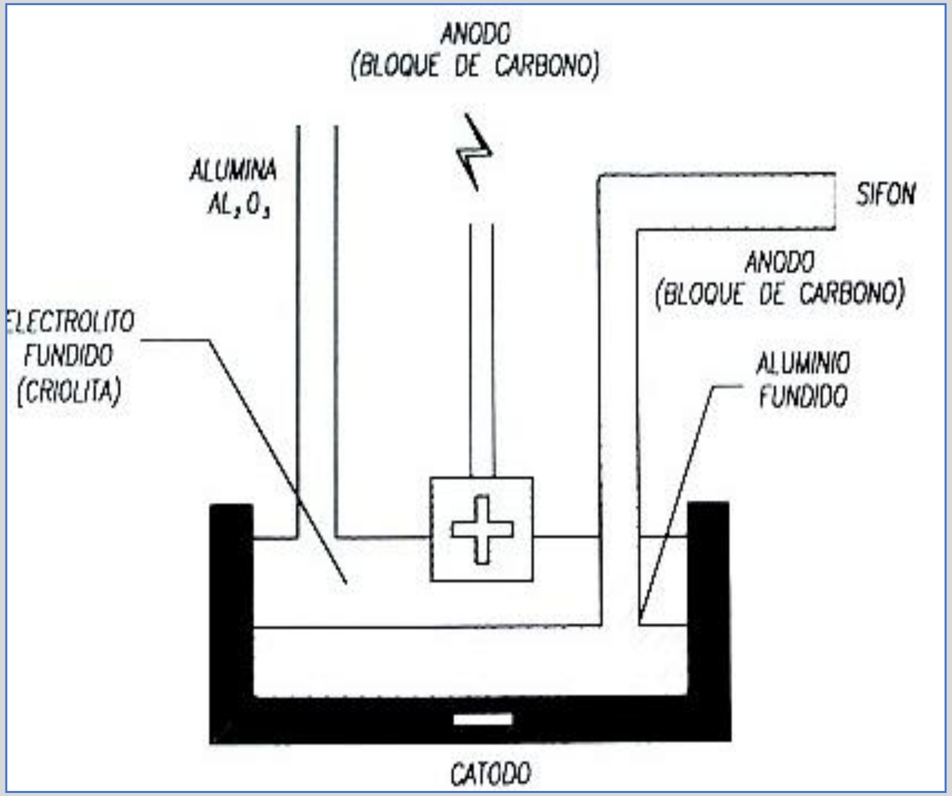
Estos residuos bajan al fondo de un tanque gradualmente y luego se extraen. Ellos son conocidos como “barro rojo”.

La solución limpia de aluminato de sodio se bombea a un tanque grande llamado precipitador. Posteriormente se adicionan partículas finas de alúmina para dar inicio a la precipitación de alúmina pura a medida que el líquido se enfría.

Finalmente se extrae la masa decantada en el fondo del tanque y luego se pasa a través de un calcinador rotativo a 1100°C para eliminar el agua.

El resultado es un polvo blanco, alúmina pura. La soda cáustica se regresa al inicio del proceso y se usa nuevamente

Proceso Electrolítico HALL- HEROULT



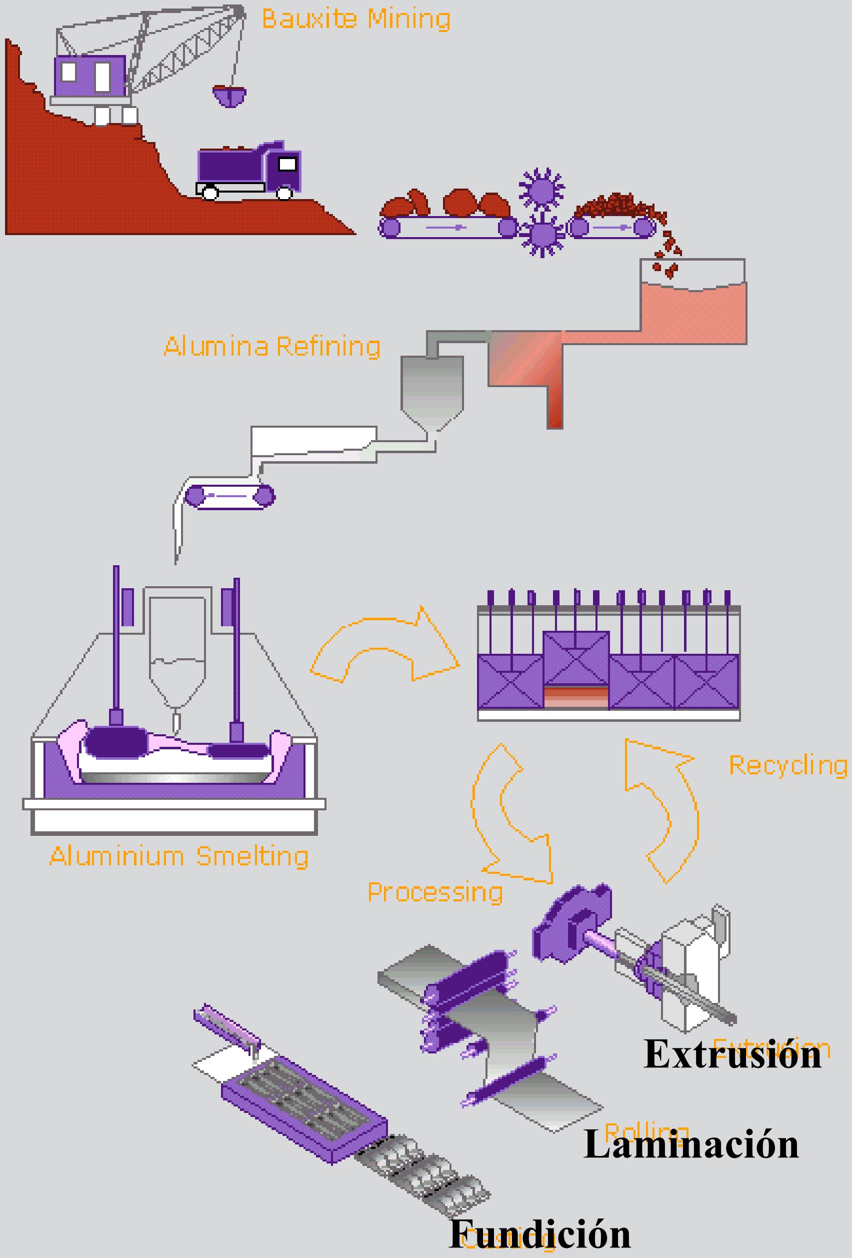
La alúmina calcinada se reduce a aluminio en celdas electrolíticas metálico conectadas a una fuente de corriente continua con electrodo (ánodo) de carbón.

Al hacer pasar corriente eléctrica a través de la celda el aluminio se separa del oxigeno y se deposita como metal en el fondo de la cuba (cátodo).

El proceso electrolítico requiere 13.5 kW hora por kilo de aluminio.

Por 2 toneladas de alúmina se obtiene una tonelada de aluminio

Producción de Aluminio primario



Minería

Producción de Alúmina

Electrólisis-Metal

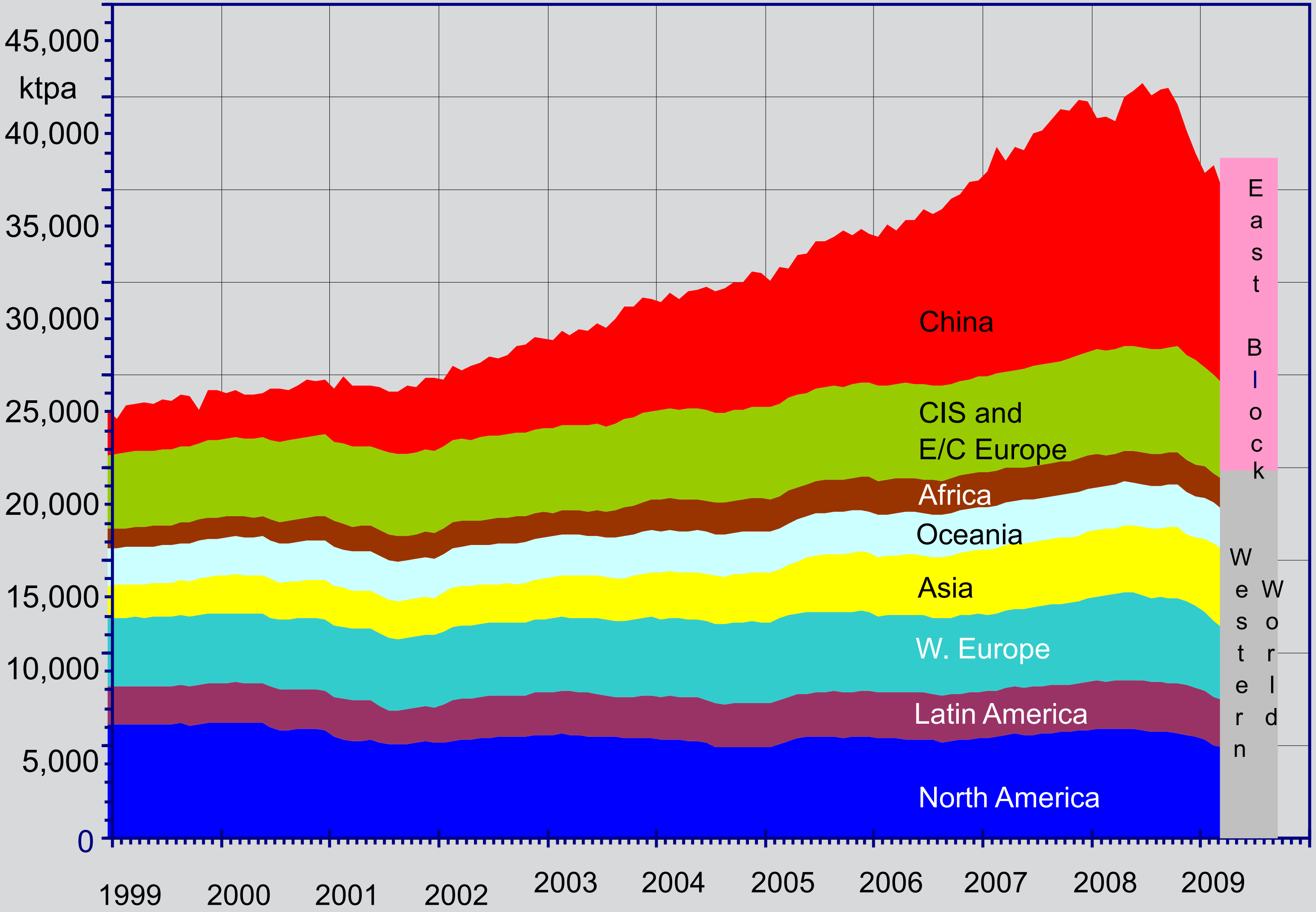
Productos semiterminados

Aluminio Primario

- **Obtenido el aluminio metálico con pureza del 97.3 y 99.8 por ciento, este pasa a moldes en forma de lingotillos o panelas para posterior refusión y formar aleaciones con otros metales.**

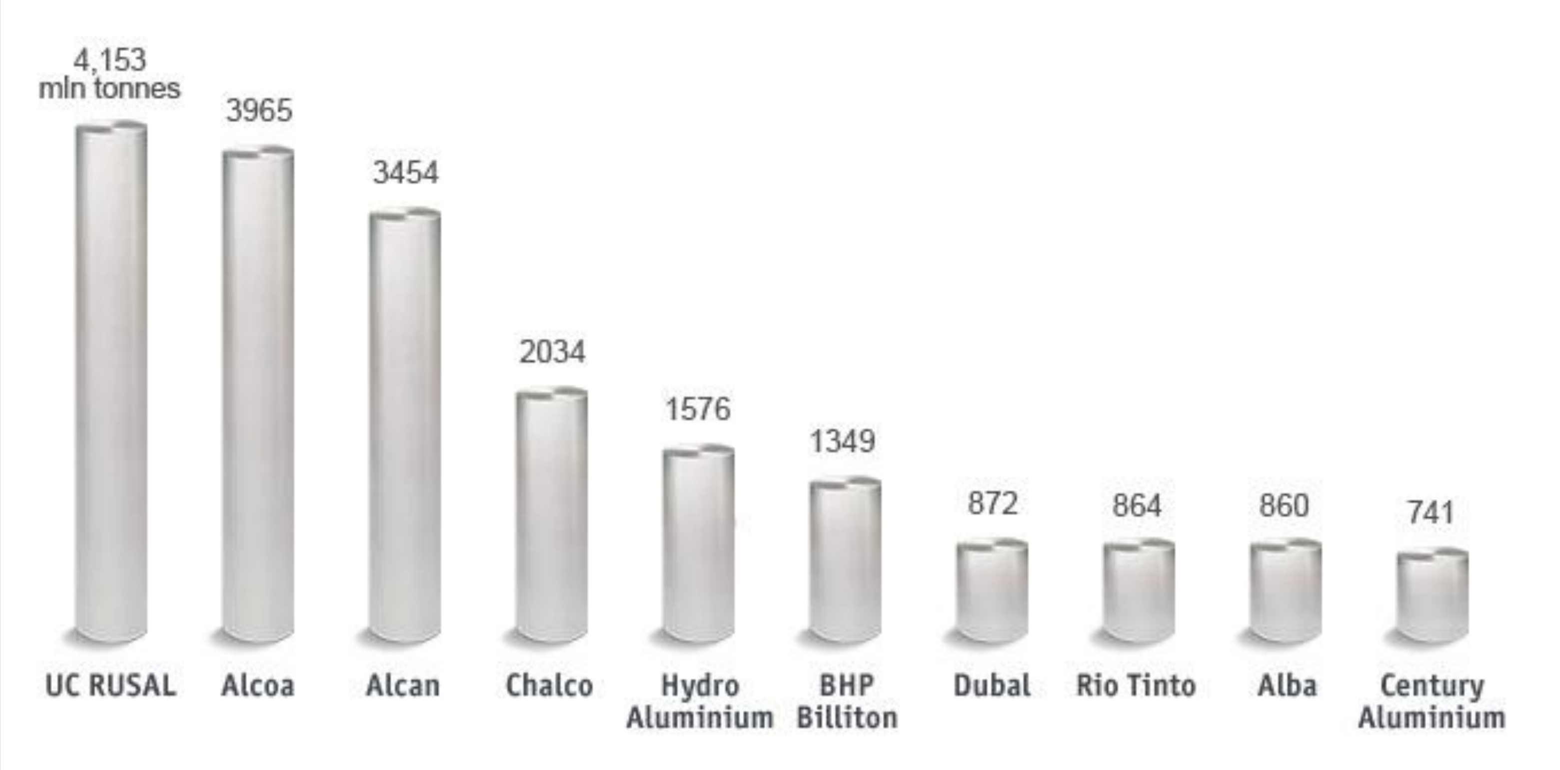
- **El aluminio primario tiene aplicación ilimitada, se combina con elementos como magnesio, cobre, zinc, hierro, boro, manganeso, silicio y otros aleantes para formar aleaciones de uso definido con propiedades físicas específicas.**

Producción mundial de aluminio primario



En los 6 años pasados la China representó 2/3 del aumento de la producción de aluminio primario

El TOP TEN de productores de aluminio

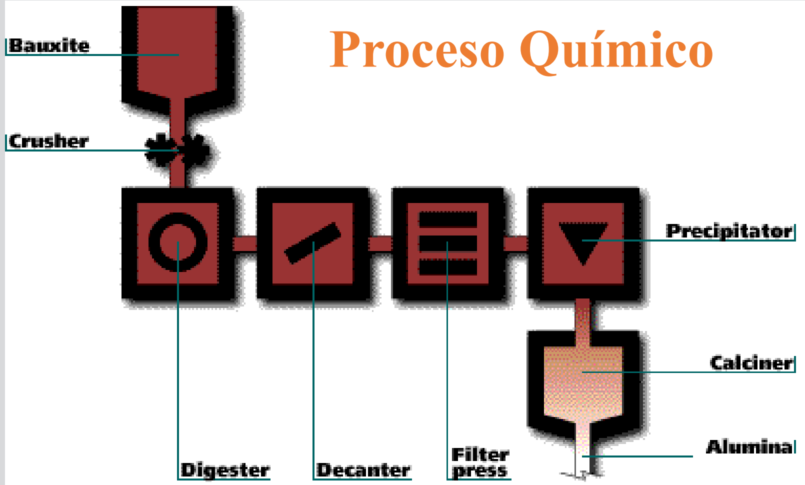


Las fuentes más ricas de la bauxita pertenecientes a la Compañía de las RUSAL (UC Rusal), que fue establecido en 2007 como resultado de la fusión de Rusal, Sual y los activos de alúmina de Glencore, Rio Tinto y CVRD, Chalco de China es la cuarta, Alcoa y Alcan, que están entre los tres productores más grandes, controlan de depósitos por valor 1,89 y 0,38 millones de toneladas respectivamente.

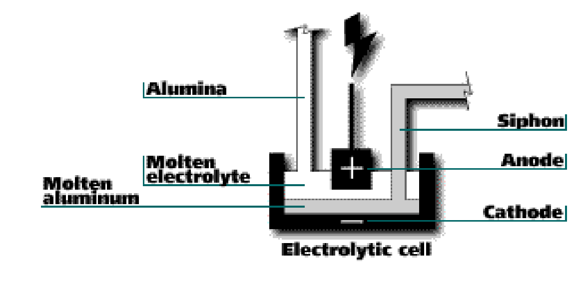
Los analistas estiman que de alúmina de Alcoa Mundial y los productos químicos (negocio de alúmina de Alcoa, con un 60% pertenecen a la empresa estadounidense y el 40% de la Alumina Limited de Australia) se produce el 19% del total de la producción de alúmina del mundo, la UC Rusal producirá poco más de 14 %, Chalco se produce el 12%, Alcan se produce el 8%, Rio Tinto producirá el 4% y 3% de CVRD. BHP Billiton (estimado es de 6%) y Noruega Hydro Aluminium (3%) también se encuentran entre los líderes de la producción de alúmina.

PRODUCCIÓN DE ALUMINIO PRIMARIO

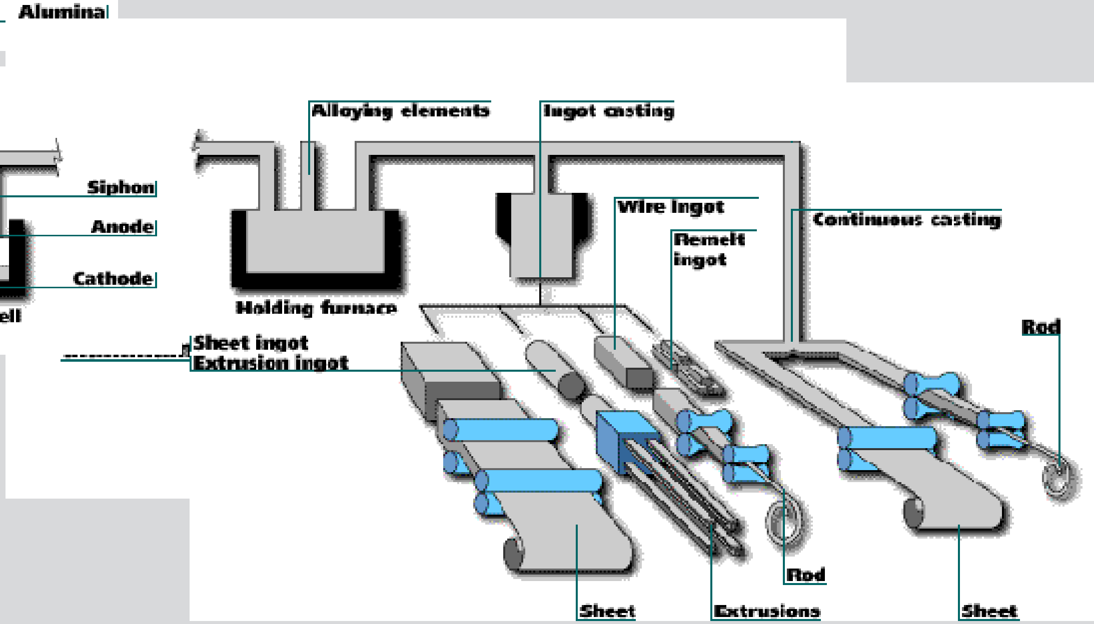
Proceso Químico



Materia prima (Al_2O_3) y producto final (Al)

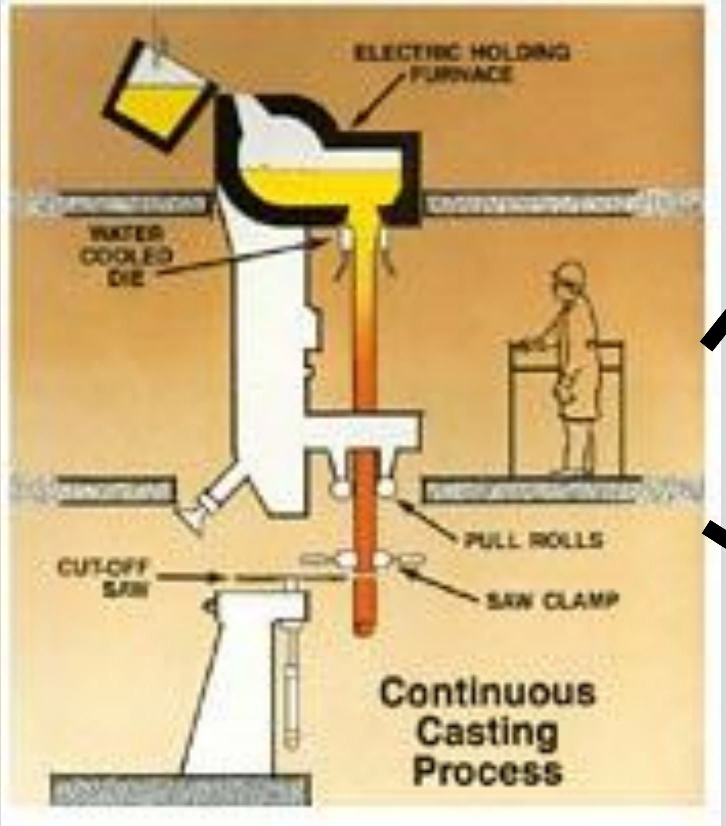


Proceso Electrolítico



Fundición y Manufactura

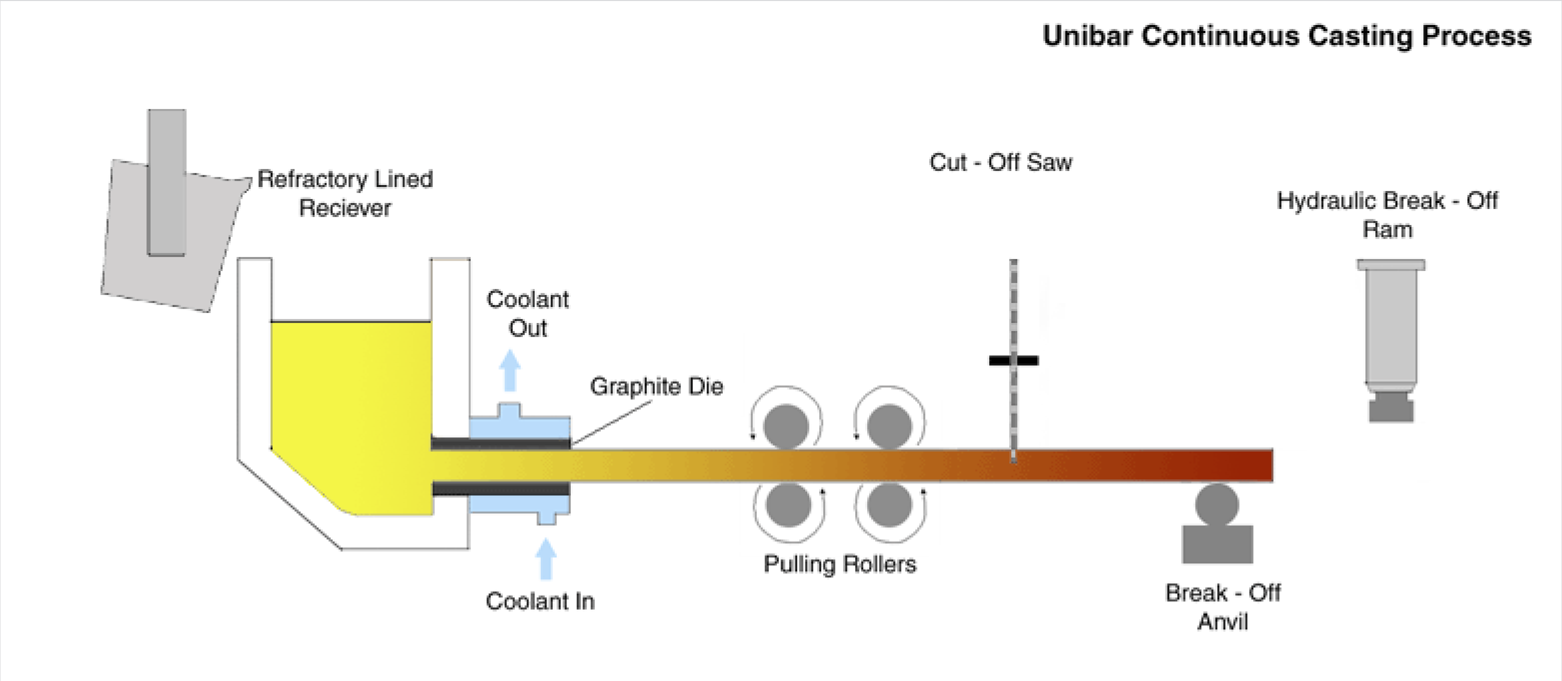
Manufactura de productos intermedios

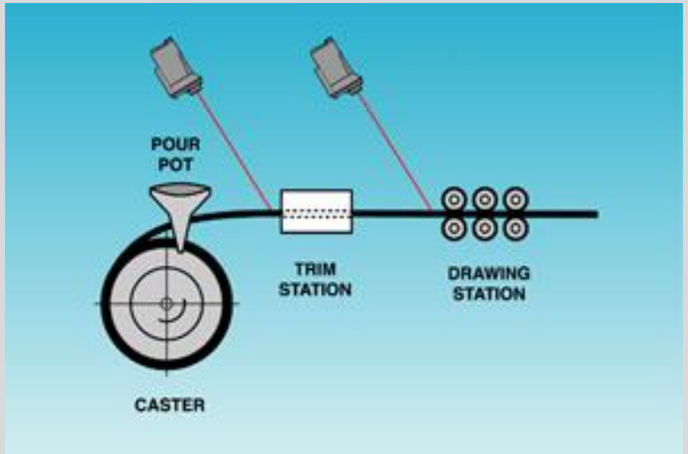


Proceso de colada continua (CC) o colada directa (DC)

Lingote para extrusión

Lingote para laminación



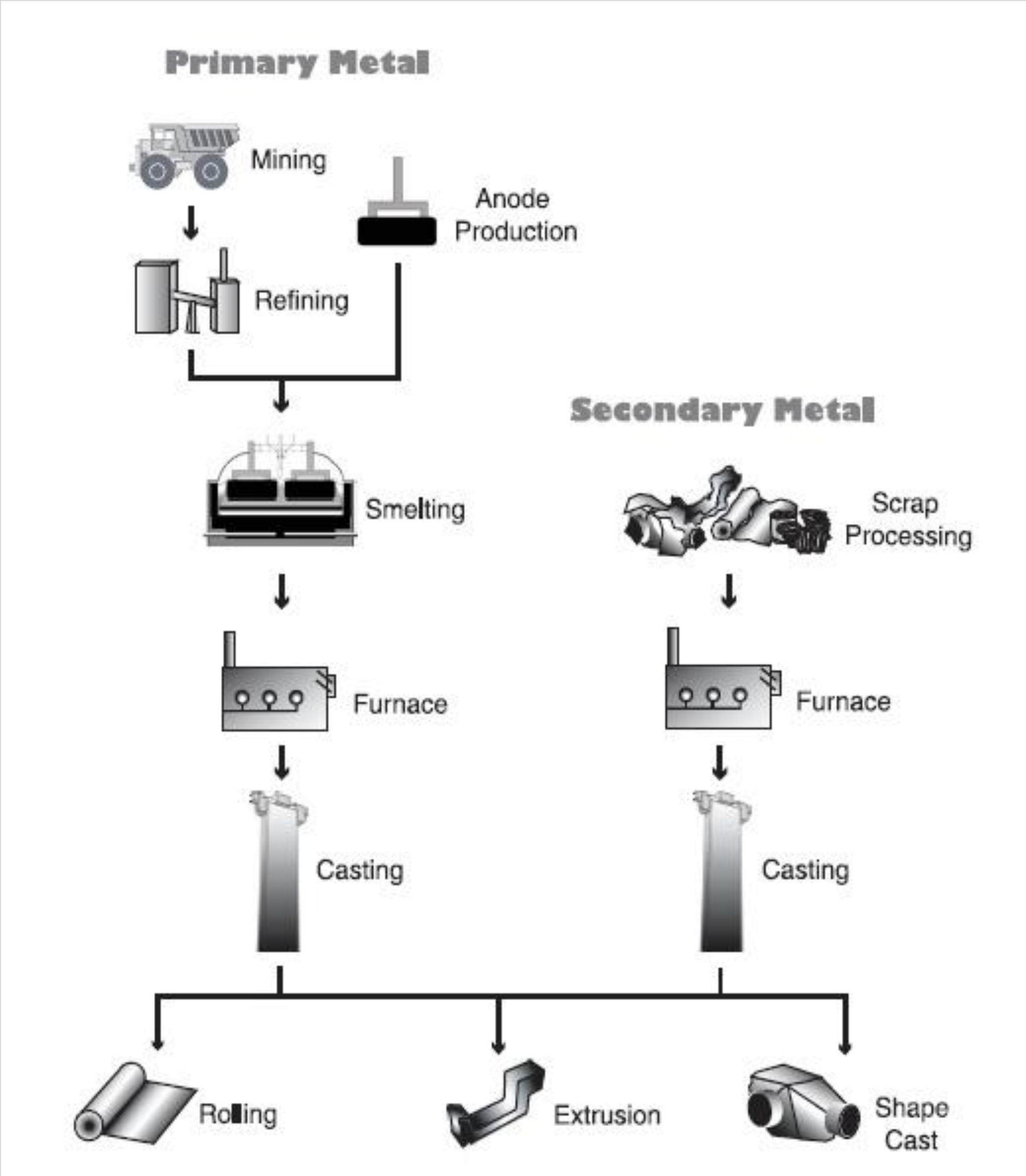


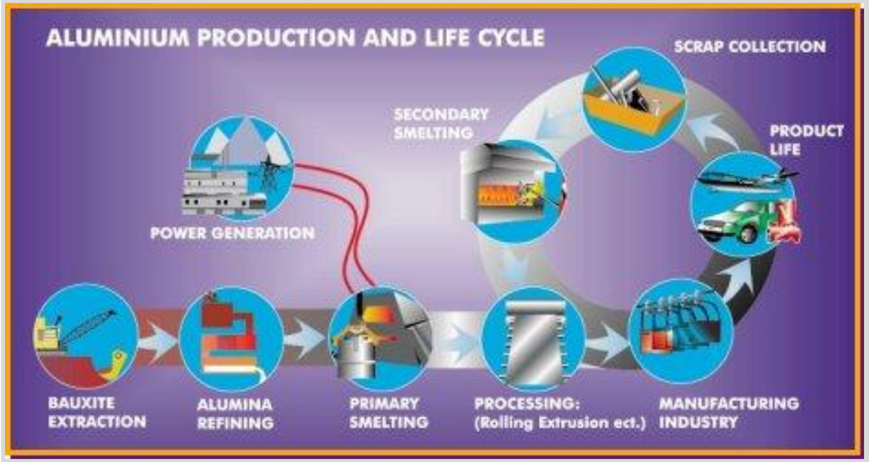
- **Alambrón para estirado**
- **Rollo para laminación**

Lingote para fundición

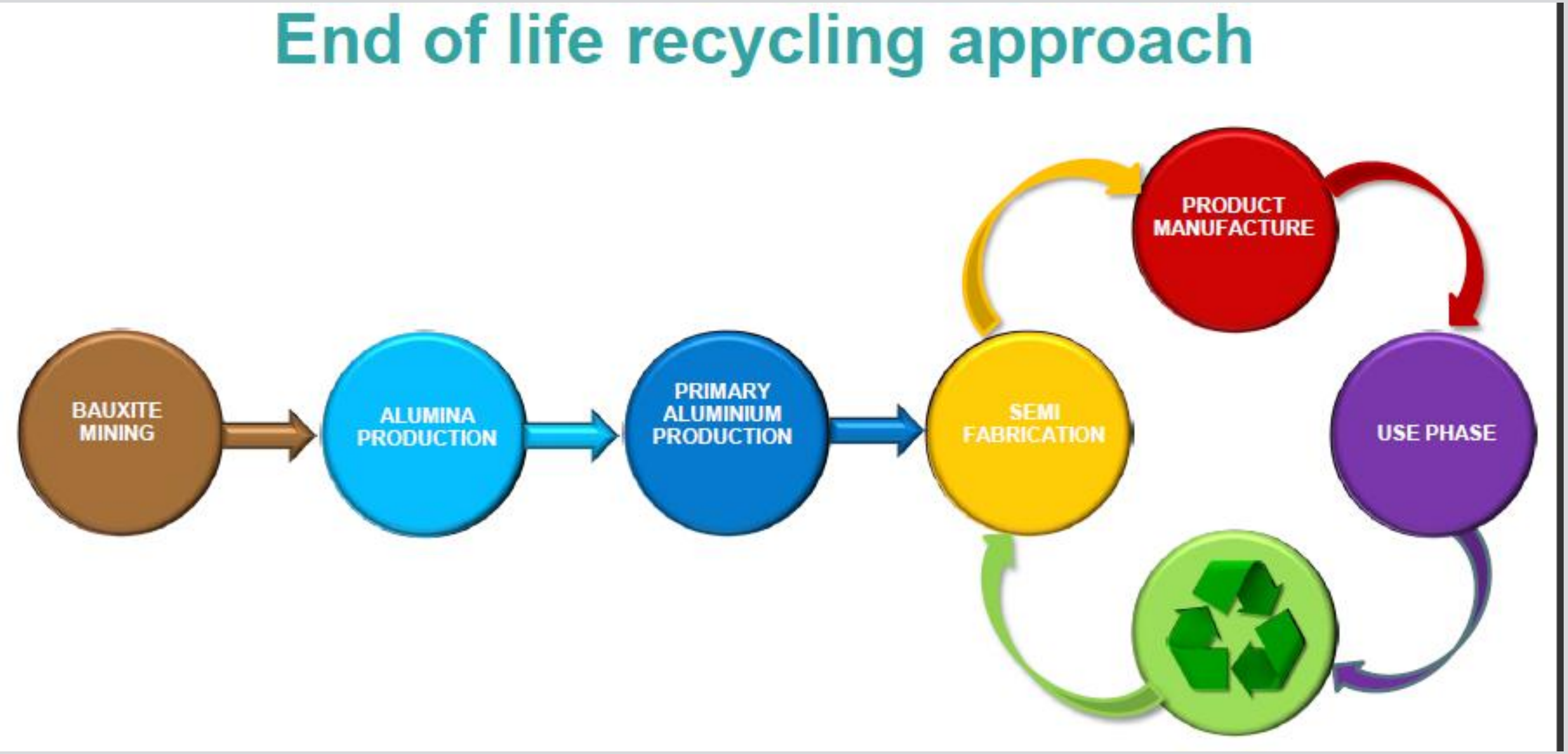
Al CASTING

PRODUCCIÓN DE ALUMINIO PRIMARIO Y SECUNDARIO

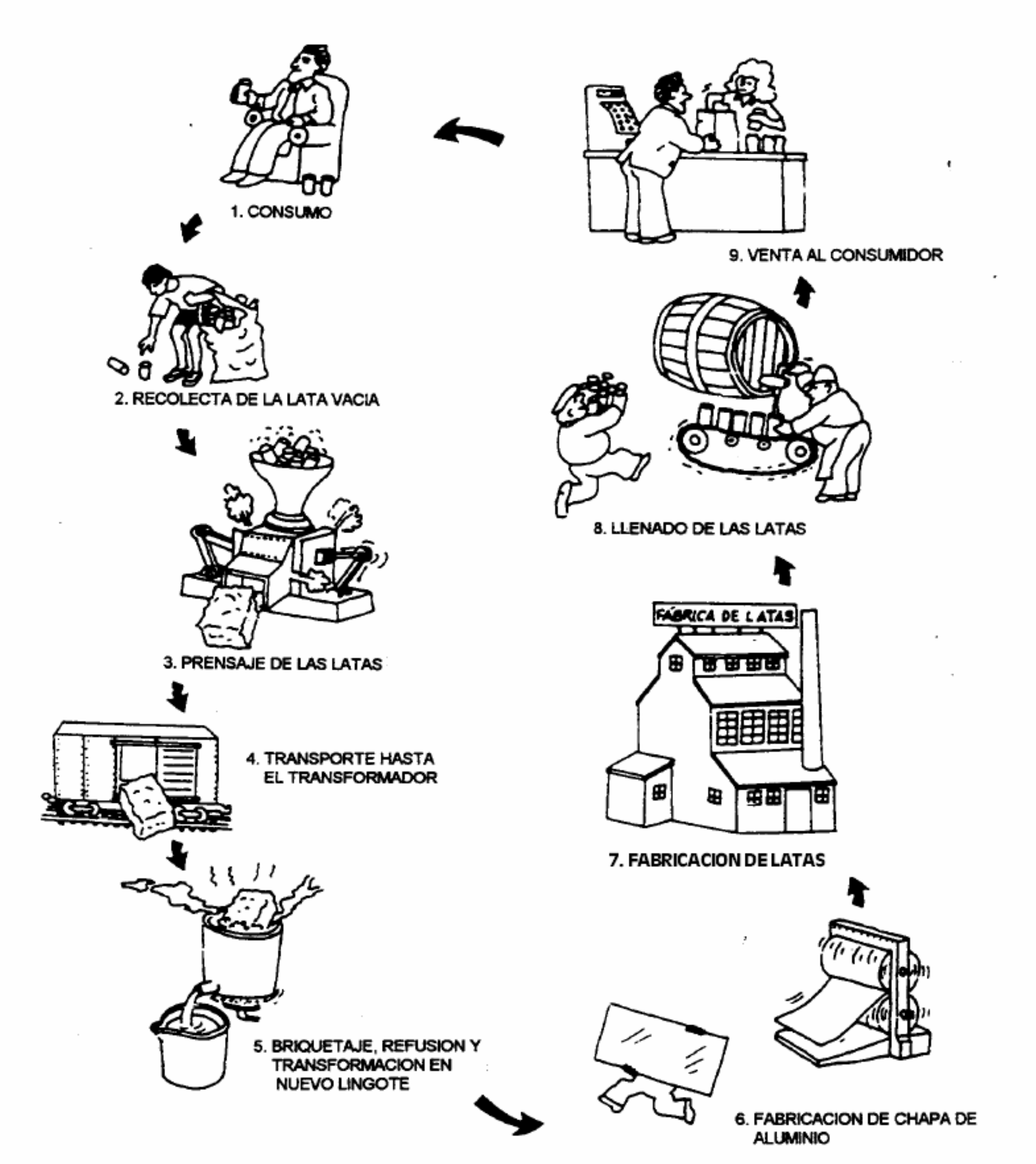




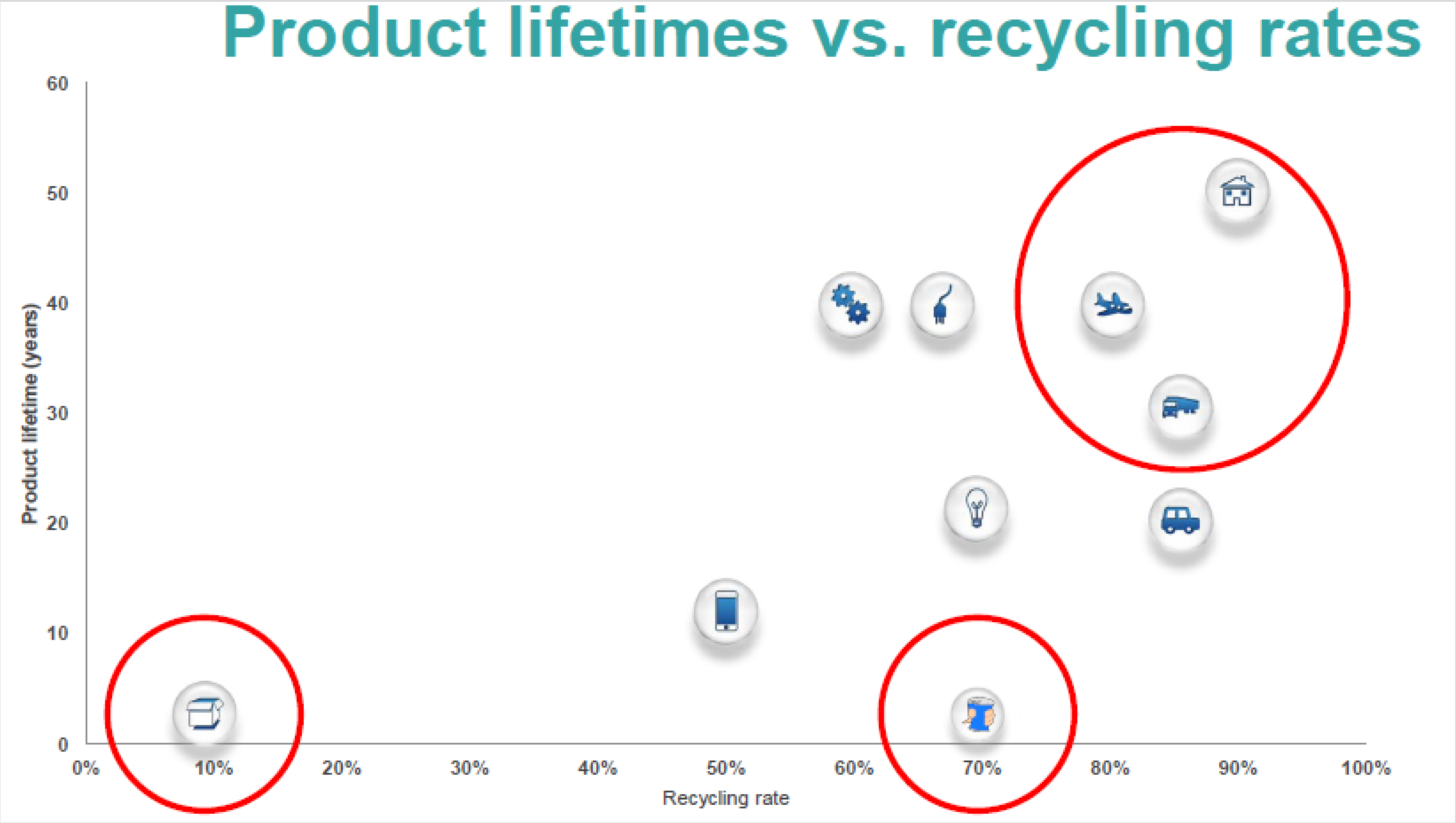
Ciclo de vida del aluminio (Reciclado)



El ciclo de la lata de aluminio (autorizado - Reynolds Latasa)

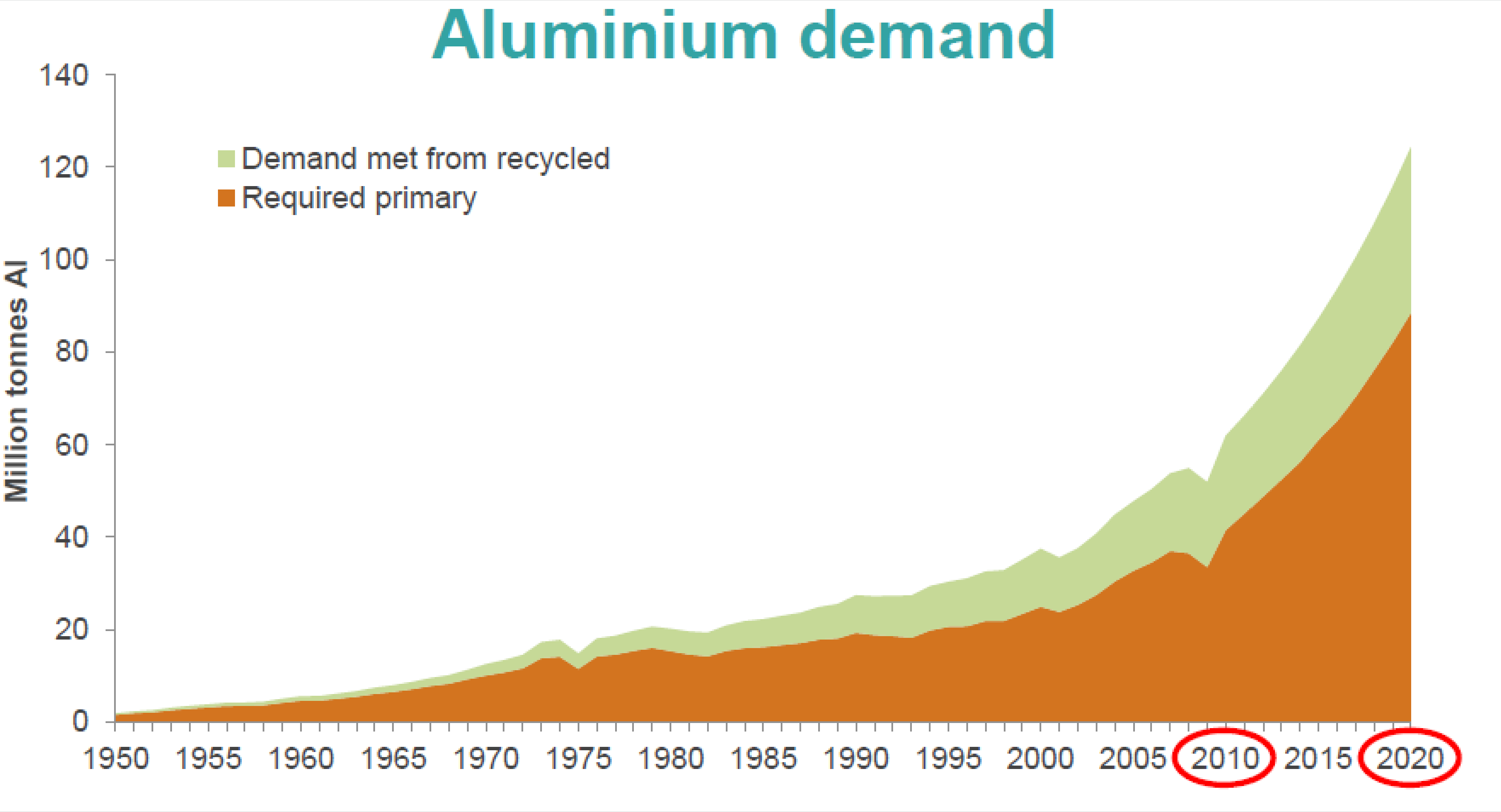


(Reciclado)

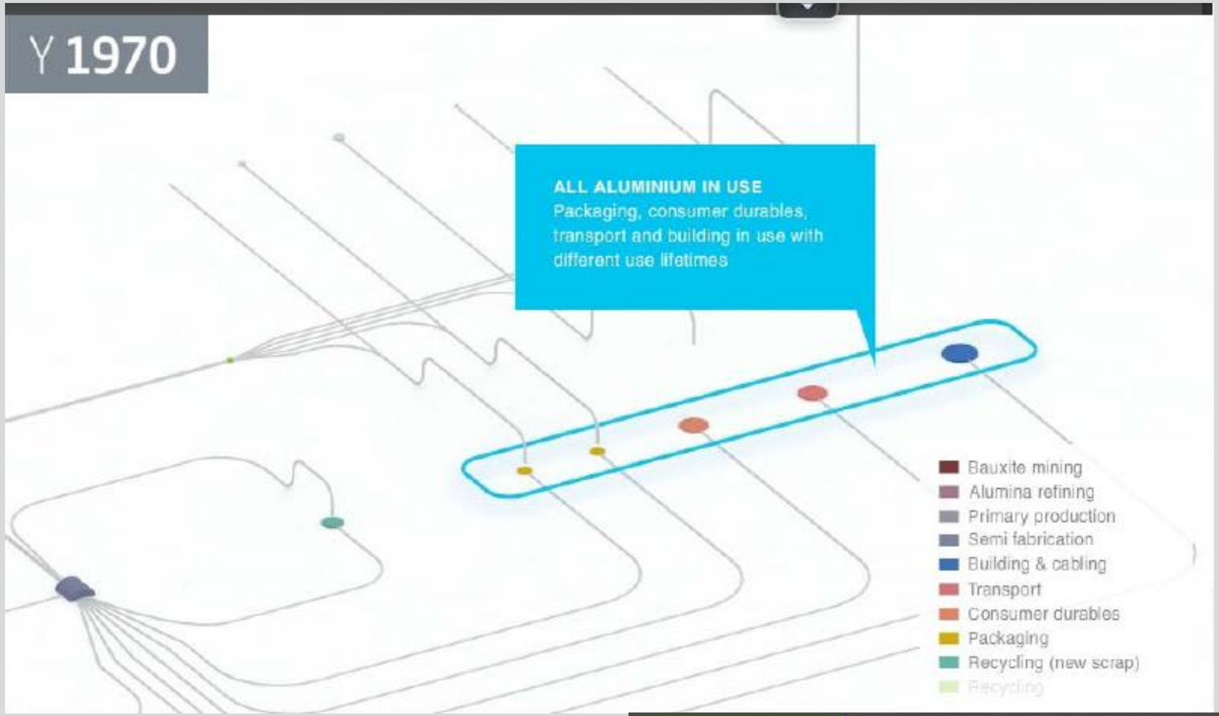


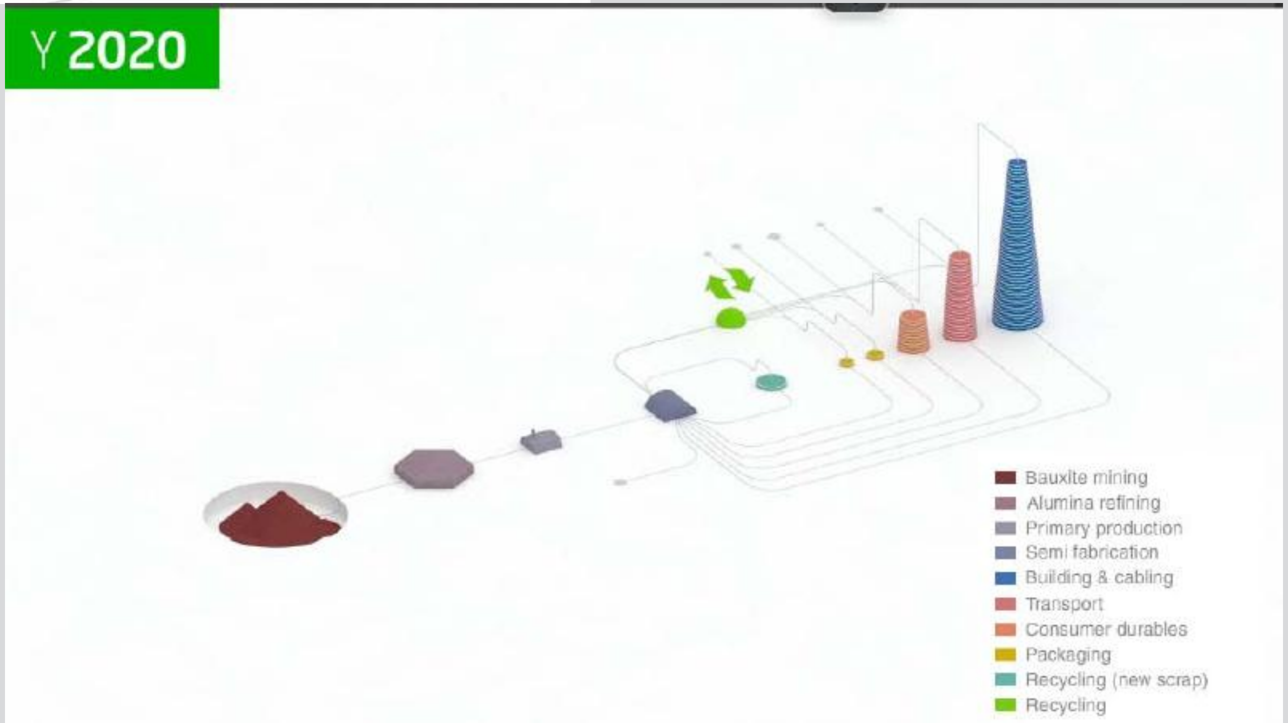
Product lifetimes vs. recycling rates
Product lifetime (years)
60
50
40
30
20
10
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Recycling rate

(Reciclado)



Aluminium demand
Demand met from recycled
Required primary
Million tonnes Al
140
120
100
80
60
40
20
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


Y 1970
ALL ALUMINIUM IN USE
Packaging, consumer durables, transport and building in use with different use lifetimes
Bauxite mining
Alumina refining
Primary production
Semi fabrication
Building & cabling
Transport
Consumer durables
Packaging
Recycling (new scrap)
Recycling


Y 2020
Bauxite mining
Alumina refining
Primary production
Semi fabrication
Building & cabling
Transport
Consumer durables
Packaging
Recycling (new scrap)
Recycling


NIVEA
Coca-Cola
ASPIRIN
ALUMINIUM IN PACKAGING
MORE

Energía utilizada en la producción de aluminio

Energía utilizada en la producción de aluminio

Table A - U.S. Energy Requirements and Potential Savings

U.S. Total Energy Requirements & Potential Savings	U.S. Annual Production 2000 Metric tons	Theoretical Minium Energy Requirement kWh (10^9)/yr (quad)	Total U.S. Process Energy Required kWh (10^9)/yr (quad)	Total U.S. Gross Energy[tf] Required kWh (10^9)/yr (quad)	Potential Gross U.S. Energy[tf] Savings kWh (10^9)/yr (quad)
Bauxite Mining					
Alumina Refining	3,985,000	0.56 (0.002)	15.00 (0.051)	16.24 (0.055)	15.68 (0.054)
Anodes Production	1,668,000	9.77 (0.033)	21.36 (0.073)	21.86 (0.075)	12.09 (0.041)
Aluminum Smelting	3,741,000	22.41 (0.076)	58.29 (0.199)	116.36 (0.397)	93.95 (0.321)
Primary Casting	3,668,000	1.23 (0.004)	3.70 (0.013)	4.56 (0.016)	3.34 (0.011)
Secondary Casting	3,450,000	1.15 (0.004)	8.63 (0.029)	9.64 (0.033)	8.49 (0.029)
Rolling	5,498,000	1.76 (0.006)	3.45 (0.012)	6.66 (0.023)	4.90 (0.017)
Extrusion	1,719,000	0.75 (0.003)	2.23 (0.008)	2.59 (0.009)	1.84 (0.006)
Shape Casting	2,513,000	0.84 (0.003)	6.42 (0.022)	6.63 (0.023)	5.79 (0.020)
Total		39 (0.131)	119 (0.406)	185 (0.630)	146 (0.498)

Energía utilizada en la producción de aluminio

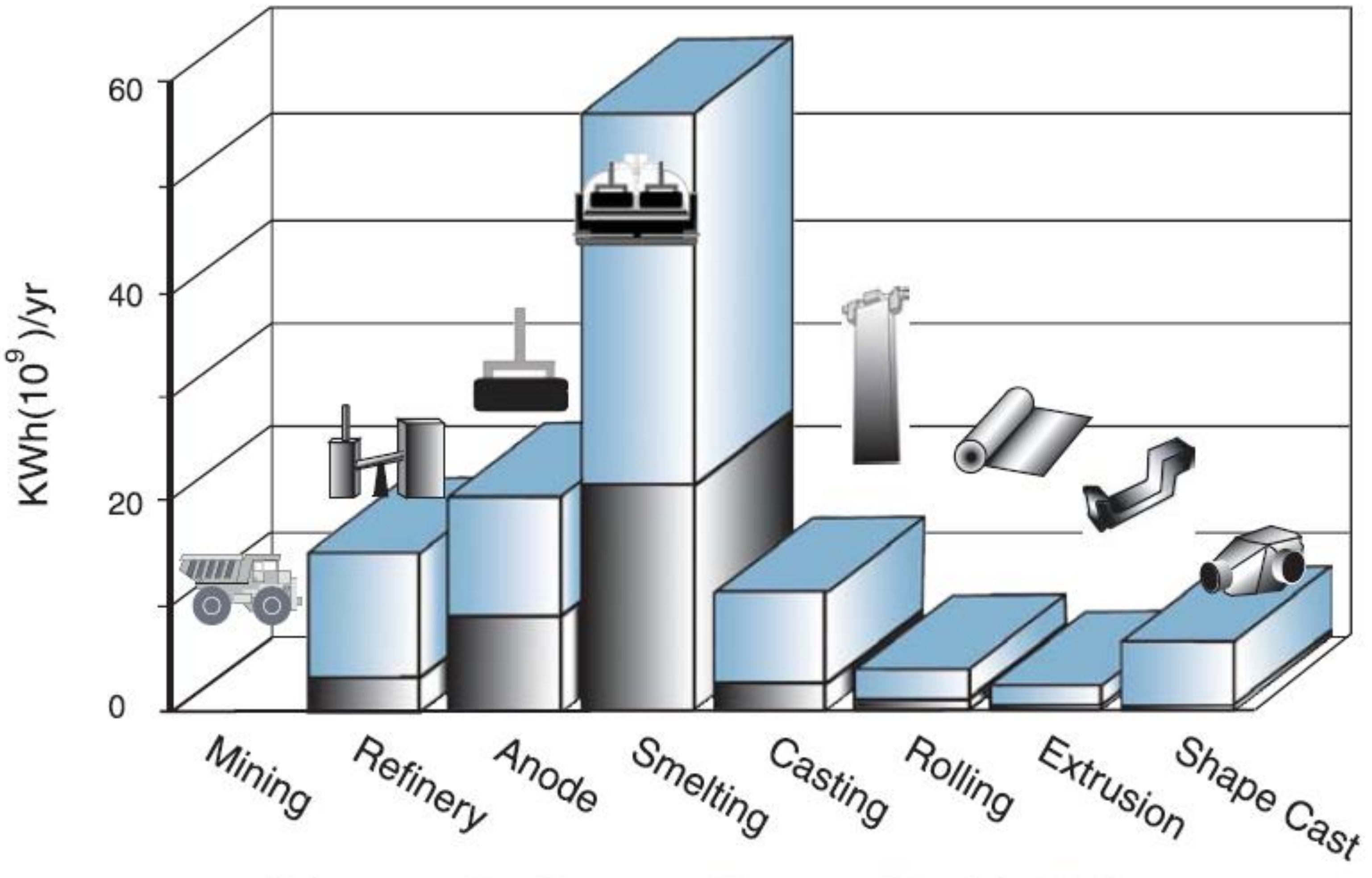
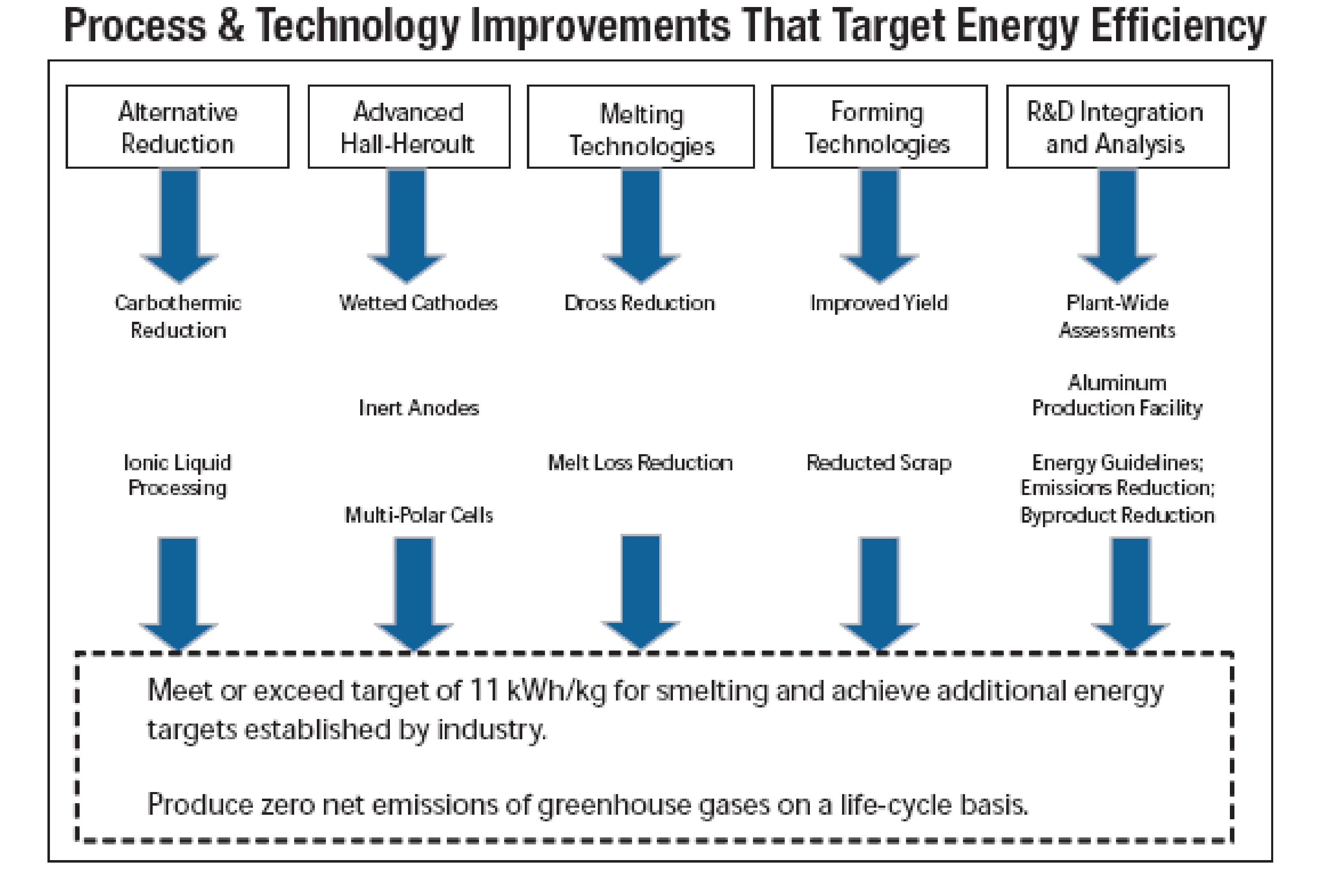


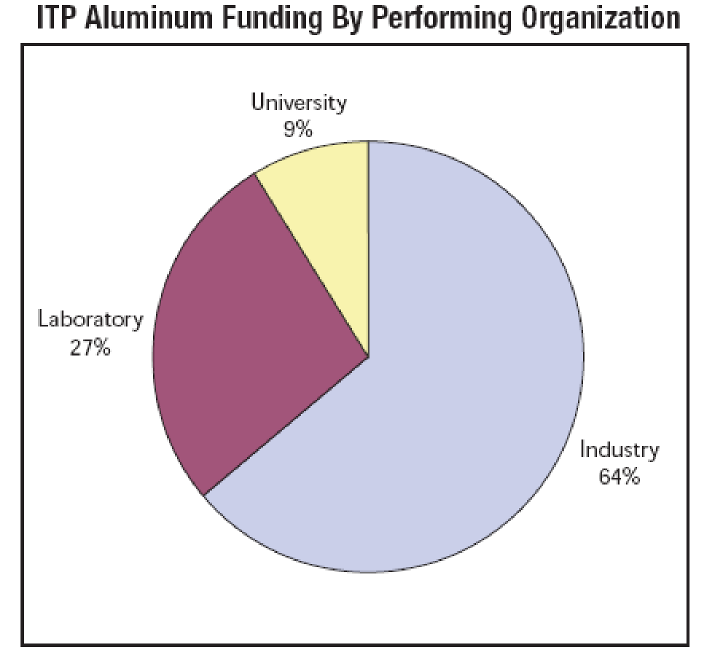
Diagram B - Process Energy Used in U.S. Manufacturing of Aluminum Products

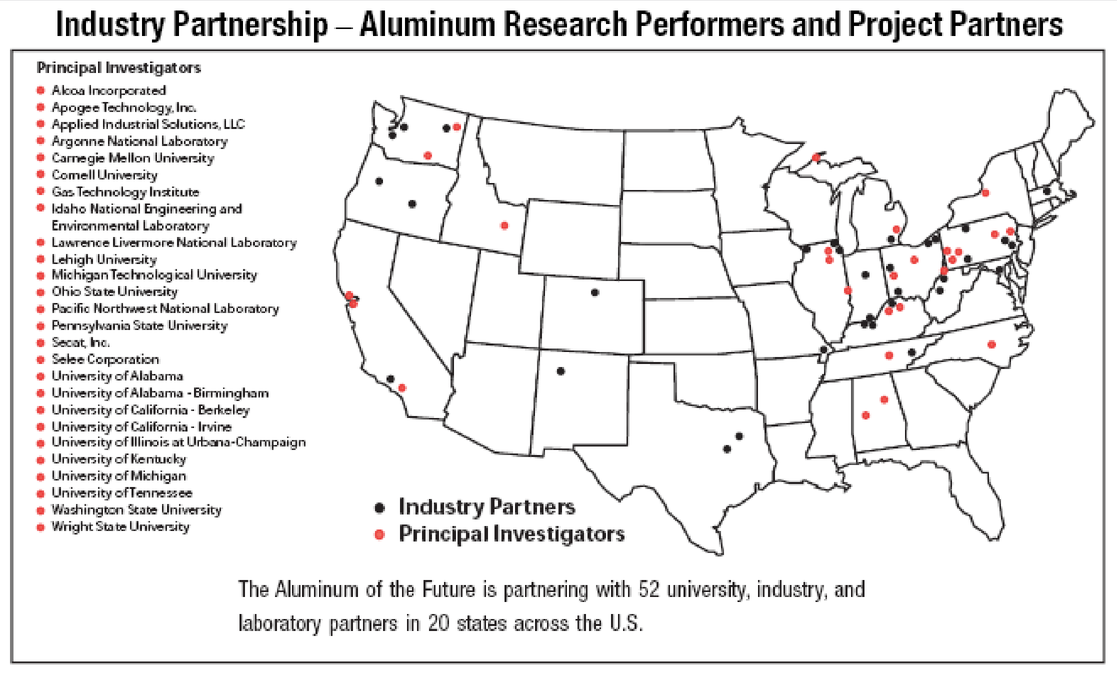
Procesos y tecnologías para mejorar la eficiencia del uso de energía

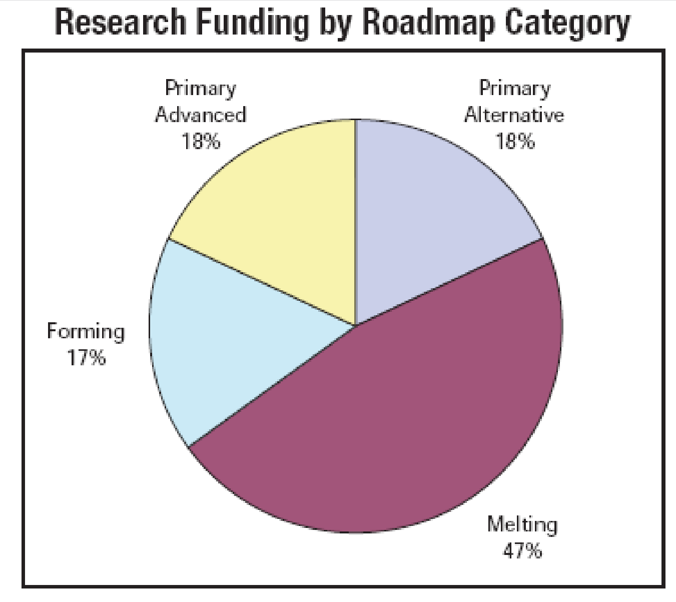


Investigación y Desarrollo R&D

Organizaciones que realizan R&D en la Industria del Al







Mapa de categorías para el desarrollo de investigación

Aluminum Portfolio by Primary Category and Project Leadership

(Fact sheets are available at http:/www.eere.energy.gov/industry/aluminum/portfolio.html)

Primary

Advanced Hall-Héroult

- Inert Metal Anodes for Primary Aluminum Production *(Argonne National Laboratory)* 1644
- Microwave-Assisted Electrolyte Cell with Inert Anode and Wetted Cathode for Primary Aluminum Production *(Michigan Technological University)* 1850
- Numerical Modeling of Transient Melt Flows and Interface Instability in Aluminum Reduction Cells *(University of Michigan)* 1853

Alternative Reduction Technologies

- Aluminum Carbothermic Technology *(Alcoa Incorporated)* 1273
- Low-Temperature Reduction of Alumina Using Fluorine-Containing Ionic Liquids *(University of Alabama)* 1854

Melting

- Energy-Efficient Isothermal Melting (ITM) of Aluminum *(Apogee Technology, Incorporated)* 1646
- Spray Rolling Aluminum Strip *(University of California-Irvine)* 1079
- High-Efficiency Low-Dross Combustion System for Reverberatory Furnaces *(Gas Technology Institute)* 1274
- Molten Aluminum Treatment by Salt Fluxing with Low Environmental Emission *(Ohio State University)* 1855
- Improving Energy Efficiency in Aluminum Melting *(Secat, Incorporated)* 1645
- Modeling Optimization of Direct Chill Casting to Reduce Ingot Cracking *(Secat, Incorporated)* 1276
- Reduction of Oxidative Melt Loss *(Secat, Incorporated)* 1277
- Selective Adsorption *(Selee Corporation)* 1272
- Gas Fluxing of Aluminum *(University of California Berkeley)* 1753
- Degassing of Aluminum Alloys Using Ultrasonic Vibrations *(University of Tennessee)* 1852

Forming

- Combined Experimental and Computational Approach for the Design of Mold Surface Topography *(Cornell University)* 1844
- Coolant Characteristic and Control in Direct Chill Casting Aluminum *(Idaho National Engineering and Environmental Laboratory)* 1684
- Development of a Rolling Process Design Tool for Use in Improving Hot Roll Slab Recovery *(Lawrence Livermore National Laboratory)* 1683
- Surface Behavior of Aluminum Alloys Deformed Under Various Processing Conditions *(Lehigh University)* 1752
- Effects of Impurities on the Processing of Aluminum Alloys *(Pennsylvania State University)* 1856
- Evaluation & Characterization of In-Lined Annealed Continuous Cast Aluminum Sheet *(Secat, Incorporated)* 1686
- Effects of Casting Conditions and Composition on Microstructural Gradients in Roll Cast Aluminum Alloys *(University of Alabama-Birmingham)* 1851
- Reduction of Annealing Times for Energy Conservation in Aluminum Processing *(Carnegie Mellon University)* 1755
- Two-Phase Model for the Hot Deformation of High-Alloyed Aluminum *(University of Illinois-Urbana)* 1754
- Structural Factors Affecting Formability of Continuous Cast Aluminum Alloys *(University of Kentucky)* 1760
- Development of Integrated Methodology for Thermo-Mechanical Processing of Aluminum Alloys *(Washington State University)* 1756
- Continuous Severe Plastic Deformation Processing of Aluminum Alloys *(Wright State University)* 1687

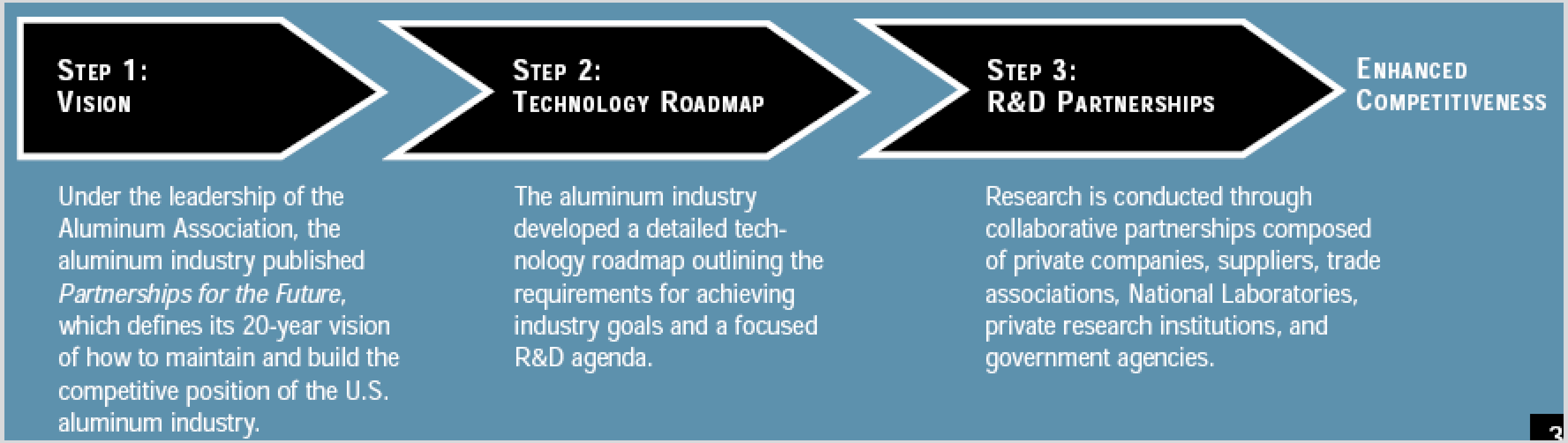
U.S. Department of Energy
Energy Efficiency and Renewable Energy

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Melting

- Energy-Efficient Isothermal Melting (ITM) of Aluminum *(Apogee Technology, Incorporated)* 1646
- Spray Rolling Aluminum Strip *(University of California-Irvine)* 1079
- High-Efficiency Low-Dross Combustion System for Reverberatory Furnaces *(Gas Technology Institute)* 1274
- Molten Aluminum Treatment by Salt Fluxing with Low Environmental Emission *(Ohio State University)* 1855
- Improving Energy Efficiency in Aluminum Melting *(Secat, Incorporated)* 1645
- Modeling Optimization of Direct Chill Casting to Reduce Ingot Cracking *(Secat, Incorporated)* 1276
- Reduction of Oxidative Melt Loss *(Secat, Incorporated)* 1277
- Selective Adsorption *(Selee Corporation)* 1272
- Gas Fluxing of Aluminum *(University of California Berkeley)* 1753
- Degassing of Aluminum Alloys Using Ultrasonic Vibrations *(University of Tennessee)* 1852

Mapa de acciones basada en la visión de la industria del Al



TAKING ACTION BASED ON INDUSTRY'S VISION

Ejemplos de proyectos prioritarios en R&D de Al

The following projects represent a sampling of the Aluminum Industry of the Future initiatives currently under way.

Detection and removal of molten salts from molten aluminum

Chloride salts, which cause defects in aluminum ingots and castings, will be detectable through a simple electrical probe and will be selectively removed from the liquid metal through a new filter, both of which were created by Selee Corporation. This project will be able to eliminate melt rejection and recasting due to salt contamination, as well as reduce chlorine use and release.

PARTNERS

Aluminum Company of America's Technical Center
Selee Corporation

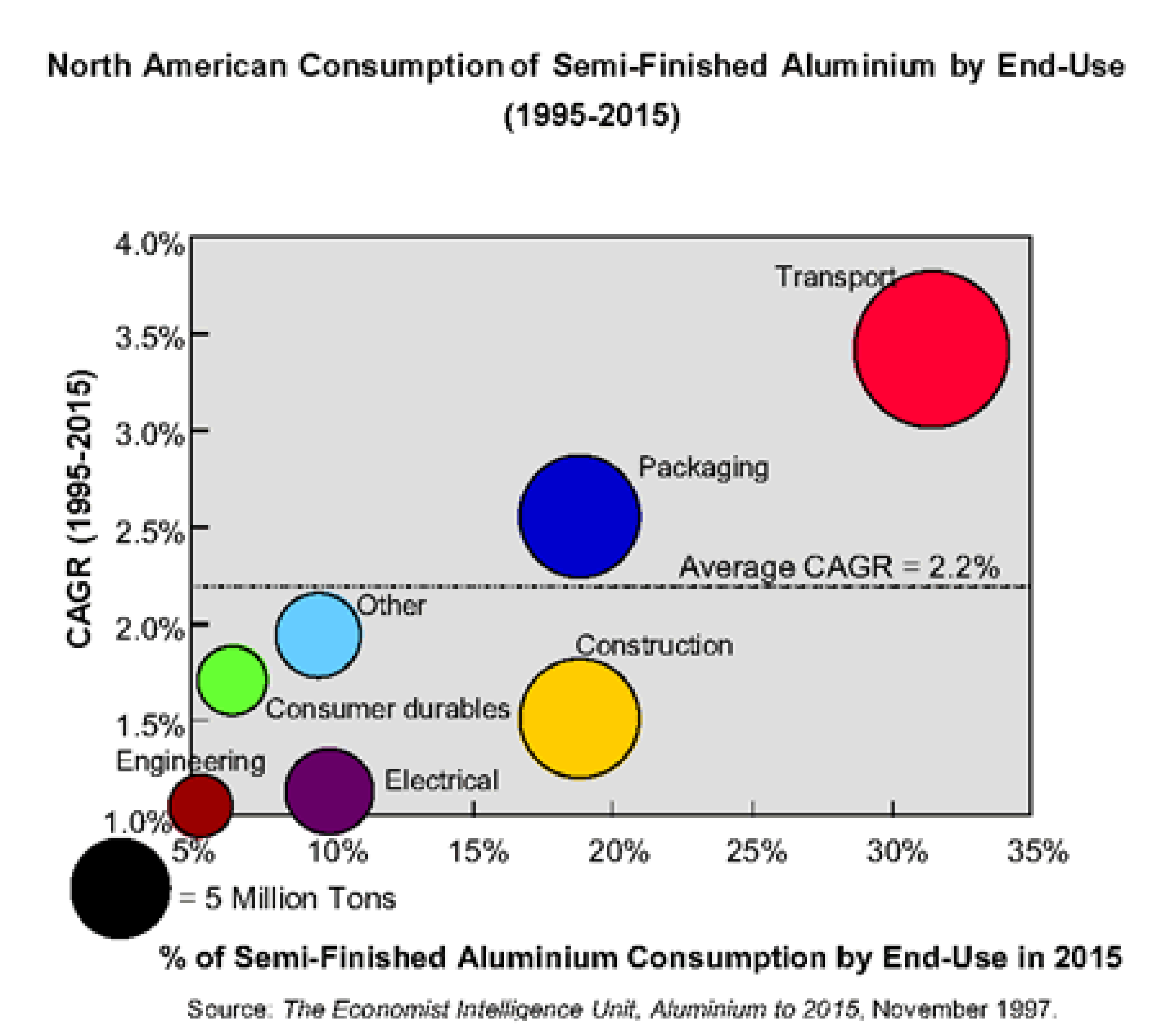
Aluminum scrap-melting oxygen-enhanced combustion

Project partners are working to develop and demonstrate a novel high-efficiency, low NOx combustion system integrated with innovative vacuum-swing-absorption oxygen generation. This integrated burner/ oxygen supply system will offer enhanced productivity, high energy efficiency, low operating costs, and low NOx emissions.

PARTNERS

Air Products & Chemicals, Inc.
Argonne National Laboratory
Brigham Young University
Roth Brothers

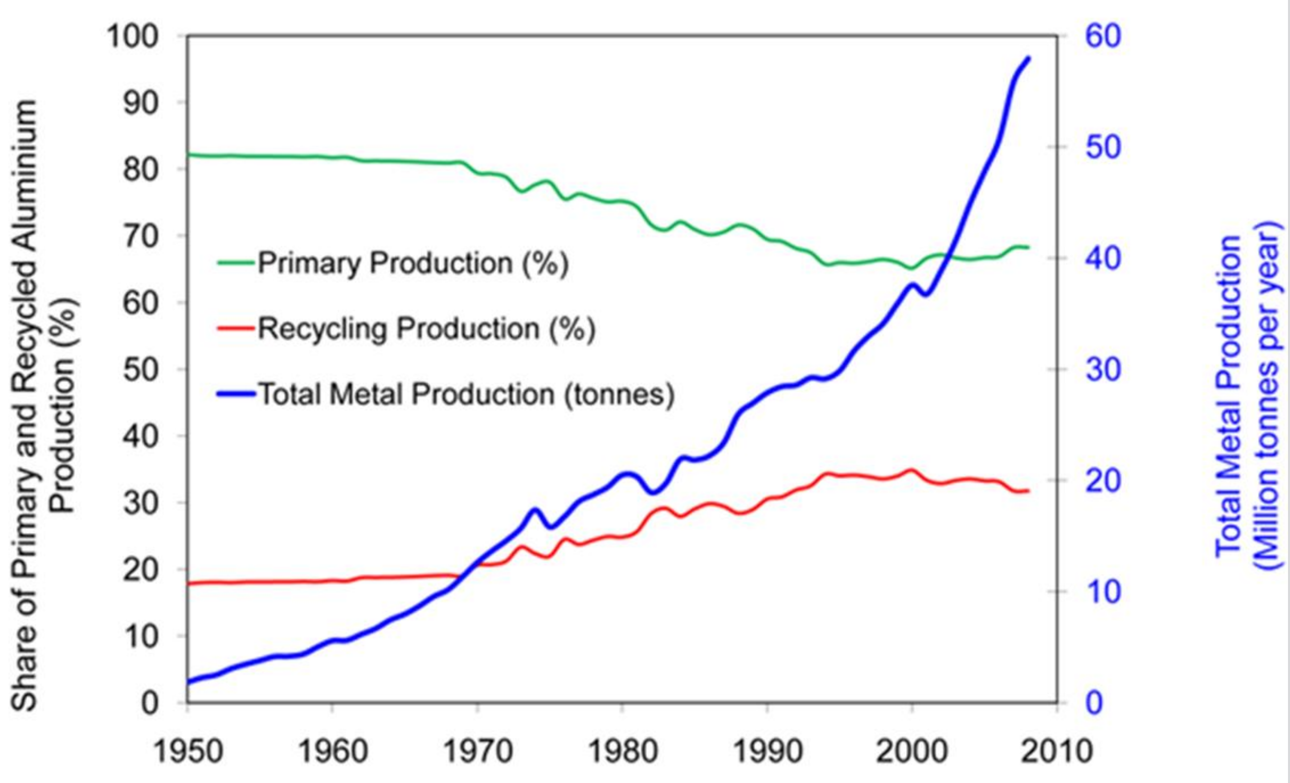
Consumo de Al en USA de productos semi-terminados y de uso final

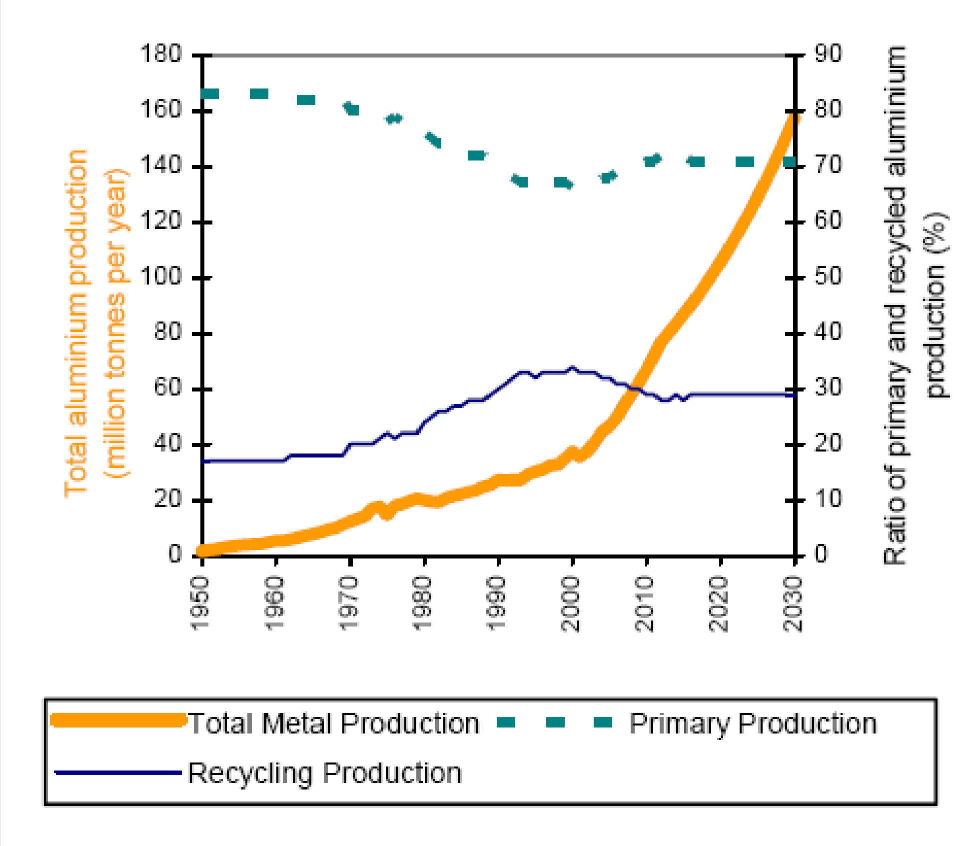


Compound Annual Growth Rate (CAGR) measures the mean annual growth rate of an investment over one year.

Producción de Aluminio: USA, Mundial México

Producción total de aluminio: primario y reciclado: perspectivas





Global Casting Production

(in 000s metric tons)

Metal	2004	2006	2008
Gray Iron	40,319	41,480	42,530
Ductile Iron	19,760	21,482	22,584
Mall. Iron	1,190	1,160	1,100
Steel	6,920	7,154	7,230
Aluminum	10,208	11,203	12,423
Oth. Nonferr.	2,450	2,580	2,700
Investment	1,007	1,960	1,100
TOTAL	**81,854**	**86,119**	**90,067**

Global Production: 2005 (metric tons)

Iron

1. China: 18.6 million
2. U.S.: 8.7 million
3. Japan: 4.8 million
4. India: 4.7 million
5. Russia: 4.3 million
6. Germany: 4 million
7. Brazil: 2.4 million
8. France: 1.9 million
9. Korea: 1.5 million
10. Italy: 1.4 million

Steel

1. China: 3.2 million
2. U.S.: 1.28 million
3. Russia: 1.2 million
4. India: 805,000
5. Japan: 276,000

Aluminum

1. U.S.: 2.08 million
2. China: 1.89 million
3. Japan: 1.48 million
4. Russia: 920,000
5. Italy: 857,000
6. Germany: 727,000
7. Mexico: 660,000
8. India: 516,000
9. Canada: 324,000
10. France: 318,000

Producción de Al en USA

U.S. Aluminum Production

Year	U.S. Primary Metal Production metric tonnes	U.S. Secondary Metal Production metric tonnes	U.S. total Supply, metric tonnes
1988	3,712,700	3,442,000	10,419,000
1999	3,778,600	3,695,000	11,154,000
2000	3,668,400	3,450,000	10,699,000
2001	2,636,500	2,970,000	9,093,000
2002	2,705,100	2,920,000	9,500,000

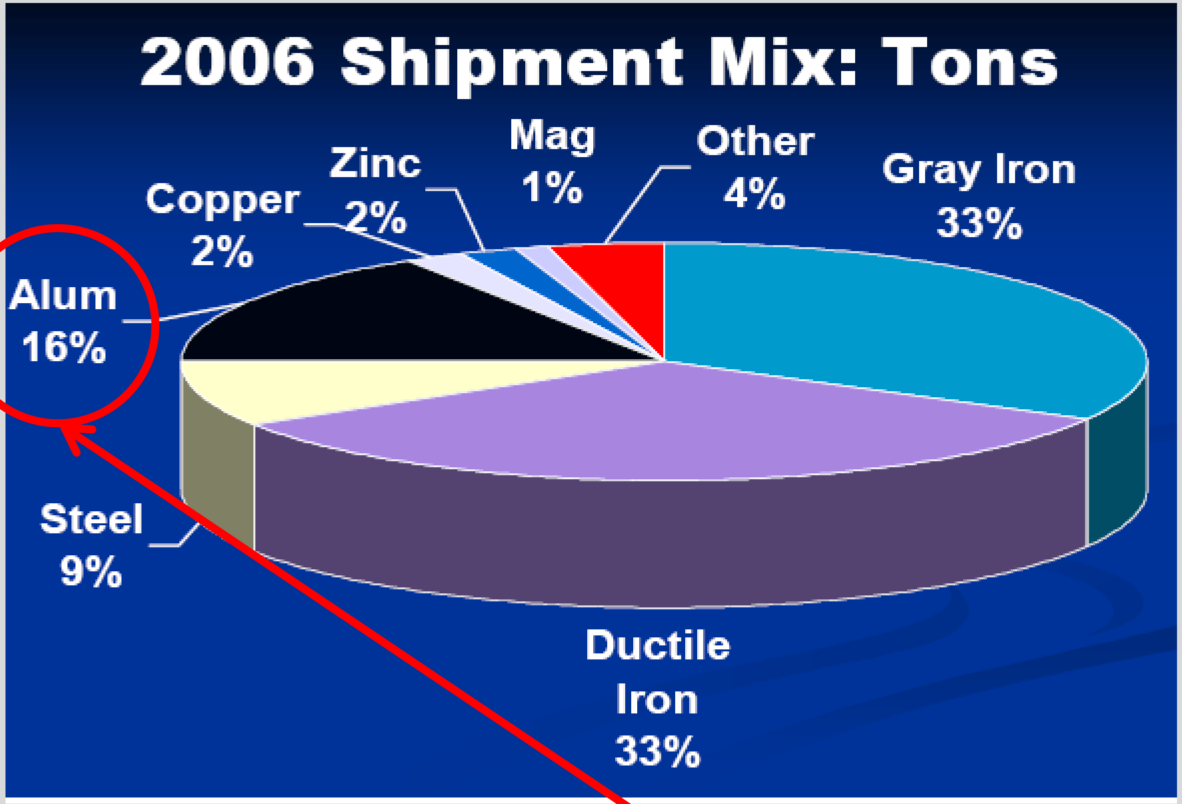
Source: *Aluminum Statistical Review for 2002*, The Aluminum Association, page 7.

Al importado por en USA

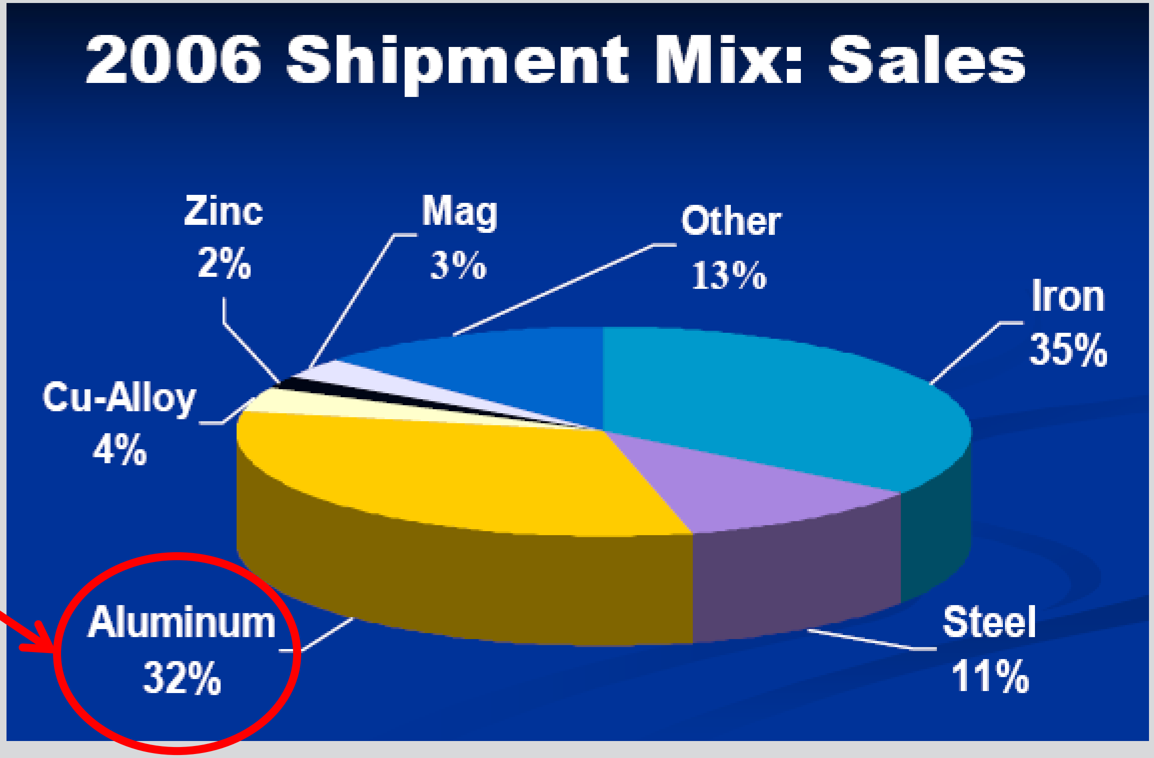
U.S. Imports by Country 2002

Country	Metric tonnes	Percent of Imports
Canada	2,554,000	58%
Russia	752,300	17%
Venezuela	235,300	5%
Australia	97,200	2%
Germany	97,600	2%

Source: *Aluminum Statistical Review for 2002*, The Aluminum Association, page 40.



Comparación en Ton producidas y ventas



Aluminum Forecast

- **2006 Shipments:** 2.3 million tons
- **2007 Forecast:** +2% ($11.2 Billion)
- **10 Yr Trend:** 1.6% annual growth
- **Total Sales**
  - 2007: $11.2 million
  - 2016: $14.99 million

Vehicle Hull Section

Aluminum Demand/Supply

- 1300 Aluminum Facilities in U.S. in 2007
  - 200 plants produce 1.8 million tons of castings
  - 1,100 plants produce 510,000 tons of castings
- Capacity Utilization in 2007
  - Diecast auto: 82% (765,000/934,000 tons)
  - Diecast other: 93% (614,000/660,000 tons)
  - Low Pressure Perm Mold: 80% (240,000/300,000 tons)
  - Permanent Mold: 86% (375,000/436,000 tons)
  - Green Sand: 83% (258,000/310,000 tons)
  - Lost Foam: 75% (150,000/200,000 t0ns)
  - Total Aluminum: 84% (2,381,000/2,840,000 tons)

Aluminum Die Casting Shipments

Forecast to 2016 (annual growth)

- Marine: 42,000 tons in ‘07 (2.6%)
- Instruments: 57,000 tons in ‘07 (2%)
- Household Appliances: 50,000 tons in ‘07(1.7%)
- Refrig & Air Condition.: 46,000 tons in ’07 (1.6%)
- Motor Vehicle and Truck: 765,000 tons in ‘07 (0.9%)
- Int. Combus. Engine: 93,000 tons in ’07 (0.8%)

Forecasts to 2016 (annual decline)

- Office Machine & Computer: 41,000 tons in ‘07 (-4.1%)

Total Sales: $5.6 billion in 2007 (1.365 million tons); $6.97 billion in 2016 (1.468 million tons)

Aluminum Perm Mold/Sand

Forecast to 2016 (annual growth)

- Motor Vehicles & Trucks: 625,000 tons in ’07 (2.9%)
- Construction Machinery: 11,000 tons in ’07 (2.7%)
- Instruments: 71,000 tons in ’07 (1%)
- Int Combus. Engine: 41,000 tons in ’07 (0.7%)

Forecasts to 2016 (annual decline)

- Office Machine & Computer: 13,000 tons in ‘07 (-3.6%)
- Motors & Generators: 7,000 tons in ’07 (-1.5%)

Total Sales: $5.7 billion in 2007 (1.023 million tons); $8 billion in 2016 (1.246 million tons)

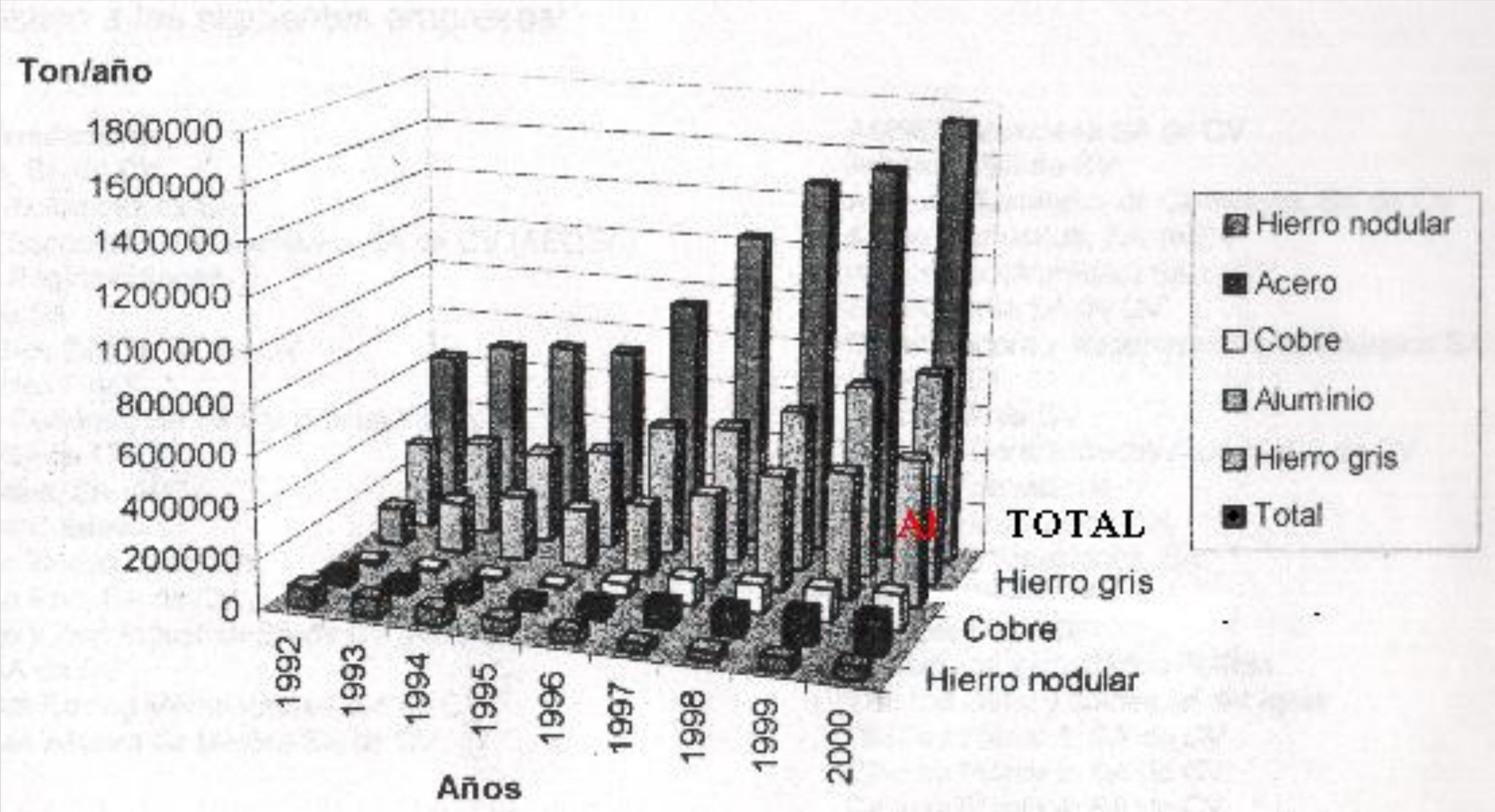
Mexico

- Casting imports to the U.S.=340,000 tons in 2007
- Capacity Utilization: 73% on ductile iron, 86% on gray iron; 79% on aluminum
- Labor rates are estimated at $2/hr for major metalcasting facilities.
- Domestic vehicle production is 1.5 million in 2004
- Real GDP has grown from -0.4 in 2001 to an estimated 4.2 in 2006

Past, Present Casting Shipment (000s tons)

METAL	1999	2001	2003	2004	2006	2008
Gray Iron	631	650	750	1100	1150	1200
Ductile Iron	44	75	200	270	310	350
Aluminum	454	540	550	540	600	700

PRODUCCIÓN DE PIEZAS COLADAS EN MÉXICO



Brazil

- Casting imports to the U.S.=330,000 tons in 2007
- Current issues with currency has made Brazil uncompetitive
- Brazil and Mexico are battling for the U.S. diesel engine block and head market. Prices can be classified as "dumping".

Casting Shipment (000s tons)

METAL	1999	2001	2003	2004	2006	2008
Gray Iron	971	950	1200	1730	1850	1800
Ductile Iron	361	350	400	597	620	650
Aluminum	98	100	140	160	180	200

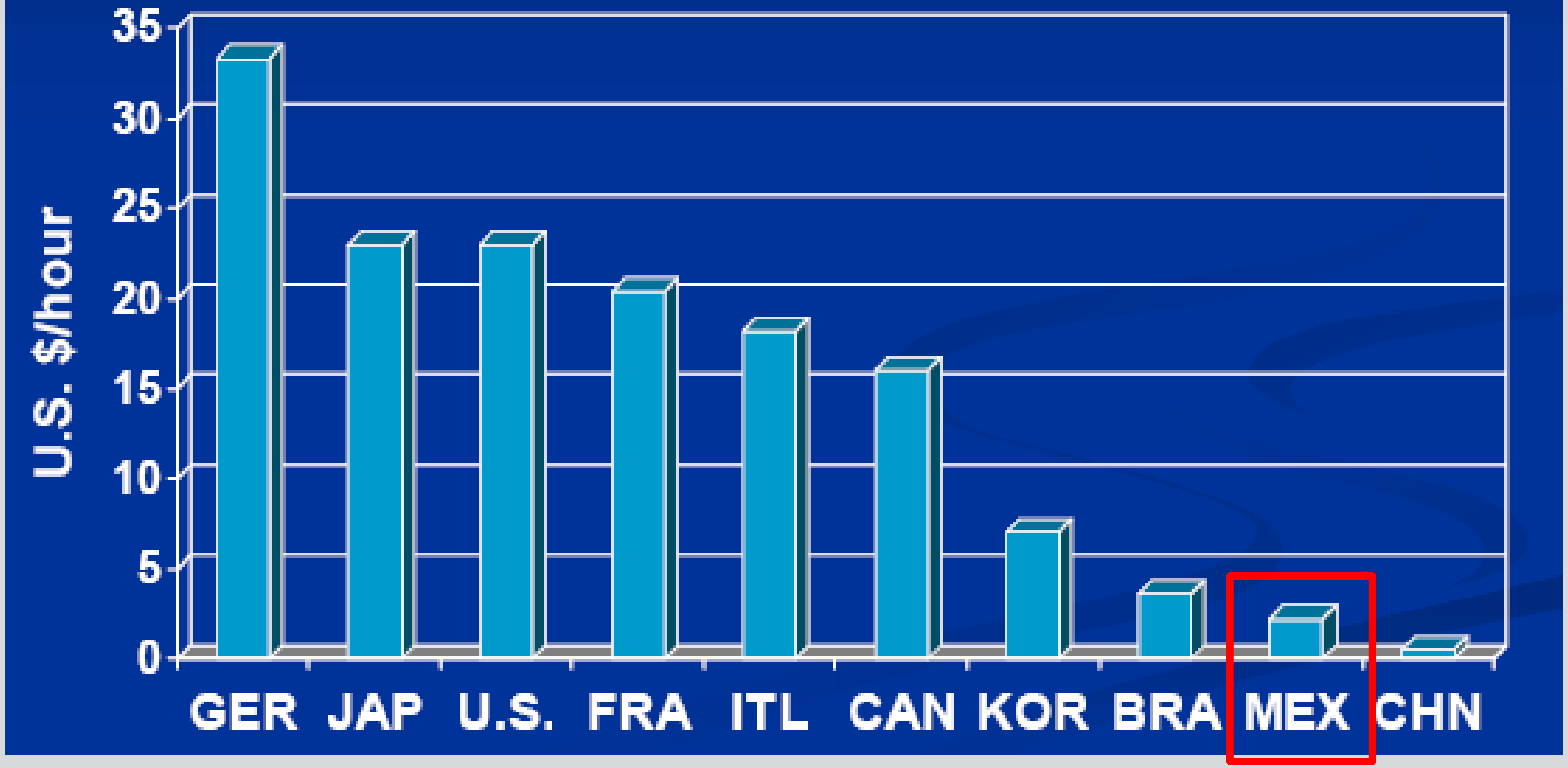
India

- Exports to the U.S.=310,000 tons in 2007
- India's car production is forecast to double in 8 years (from 760,000 auto/lt truck in 2001 to 1,100,000 in 2004).
- Capacity Utilization: 84% for gray iron, 80% for ductile iron and 81% for aluminum

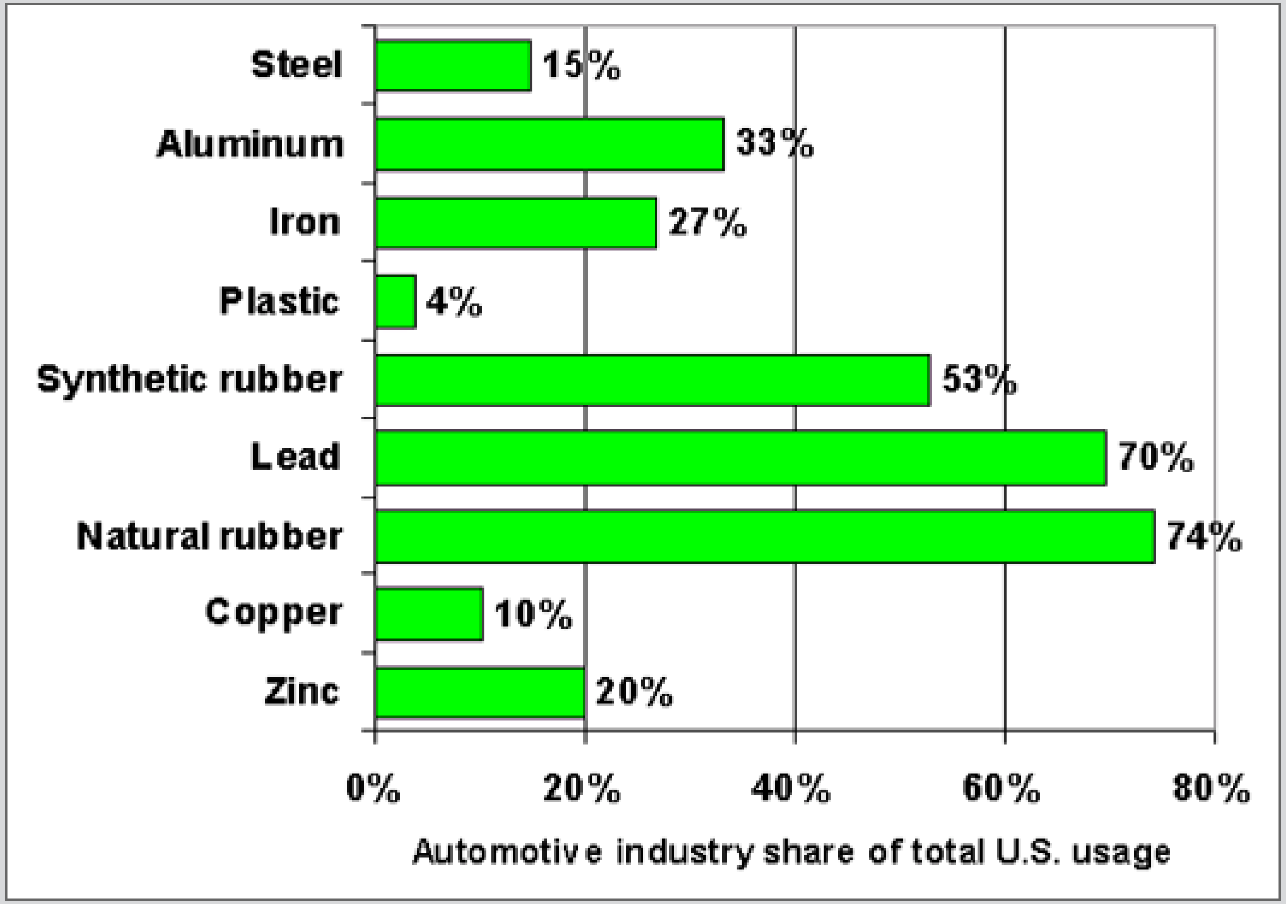
Casting Shipment (000s tons)

METAL		2004	2006	2008
Gray Iron		3180	3225	3350
Ductile Iron		442	480	520
Aluminum		300	350	410

Comparison of Foundry Labor/Benefit Rates 2007



Uso de Al en automóviles



Automotive Industry Share of Total U.S. Material Use, 2003

The Switch to Aluminum

Part	2005	2007	2009
Engine Block	50%	60%	75%
Cylinder Head	93%	96%	98%
Intake Manifold	33%	24%	10%
Transmission Case	98%	97%	97%
Wheels	75%	70%	70%
Suspension	30%	45%	50%

130 lb Al Castings/vehicle in 1992; 260 lb. in 2007; 280 lb by 2016

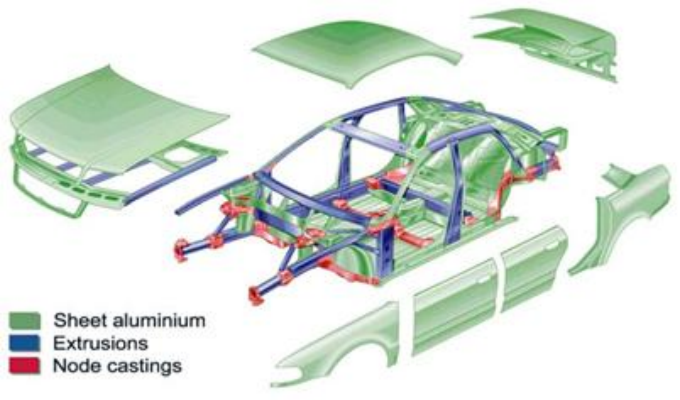
Material Used by the Automotive Industry, 2003

	Tons of Material	Automotive Industry Share of Total U.S. Consumption
Zinc	210,000	20%
Copper	362,000	10%
Natural rubber*	882,000	74%
Lead	1,143,293	70%
Synthetic rubber*	1,166,445	53%
Plastic	2,058,998	4%
Iron	2,480,000	27%
Aluminum	3,880,500	33%
Steel	15,882,831	15%

* Rubber (natural and synthetic) data are for 2002.
Source: Ward's Communications, *Ward's Motor Vehicle Facts and Figures 2004*, p.56, and 2003 Edition, p. 57.

Productos finales (Fundición) aplicaciones

Industria automotriz

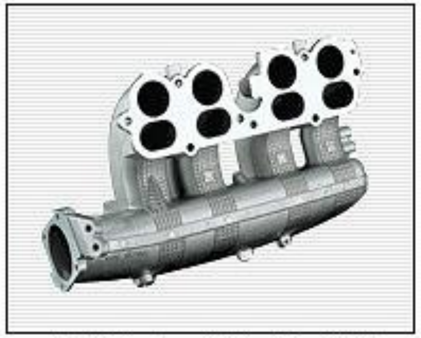


Piezas coladas automotrices de aluminio

Water Pump

Cylinder Head

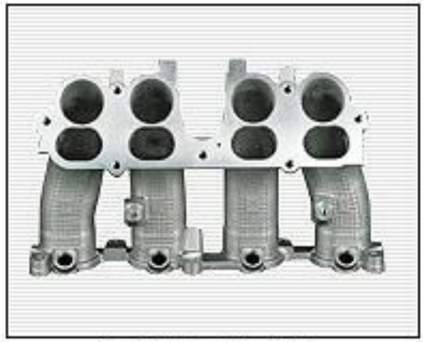
Hub Shell



Collector-Intake Manifold

Cylinder Head

Shock Absorbers



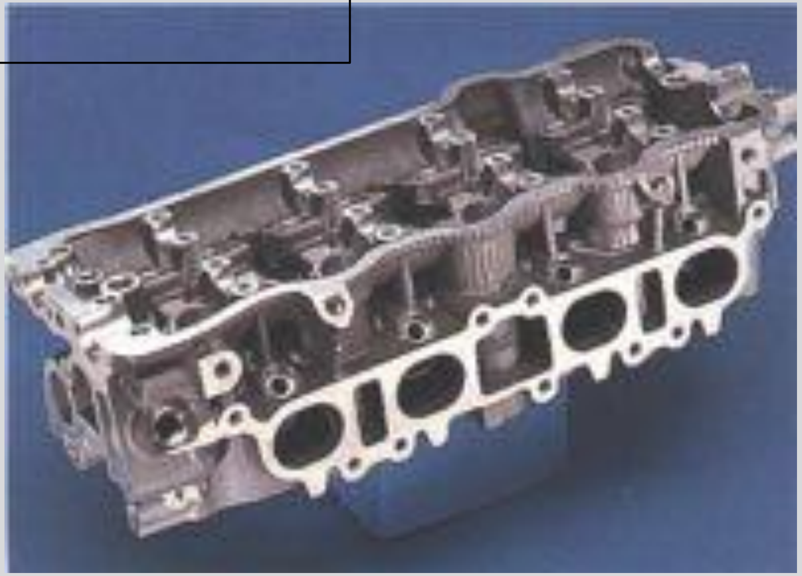
Intake Manifold

Water Outlet

Compressor Bracket

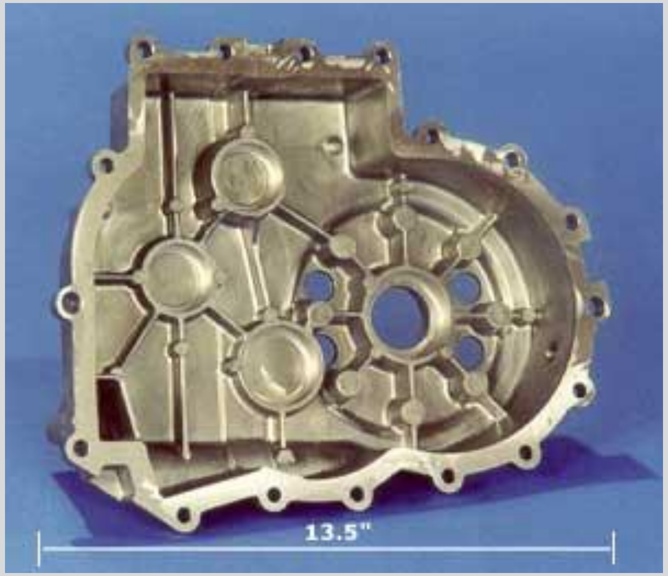
Flange

Más piezas

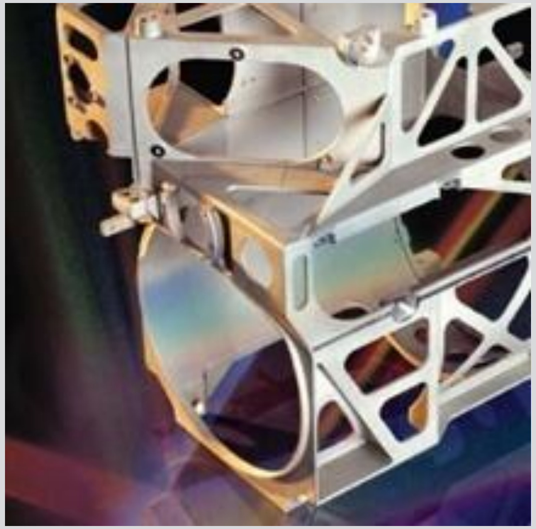





Mat Black
Black w/
Polished Lip
Silver
Titanium
Hyper Black


13.5"

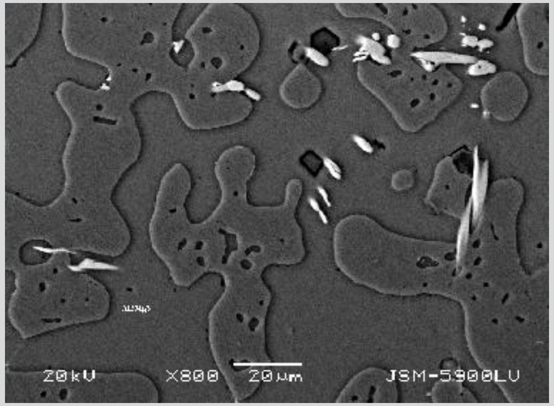
Otros componentes de aluminio colado



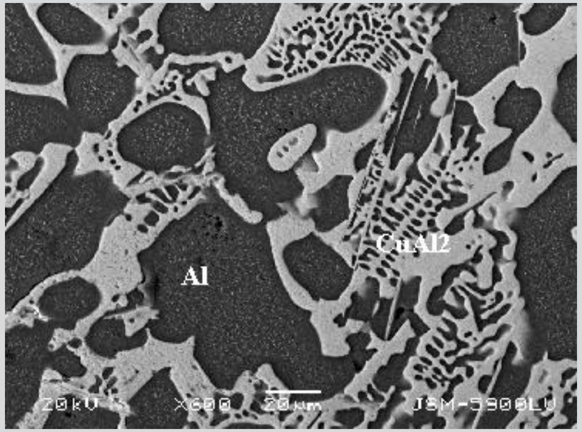
Componente aeroespacial

Fabricación de aleaciones maestras
(Master Alloys)

Al-10Ni



Al-22Mg



Al-27Cu

Aplicación: se facilita la introducción de aleantes en las aleaciones durante el proceso de fusión

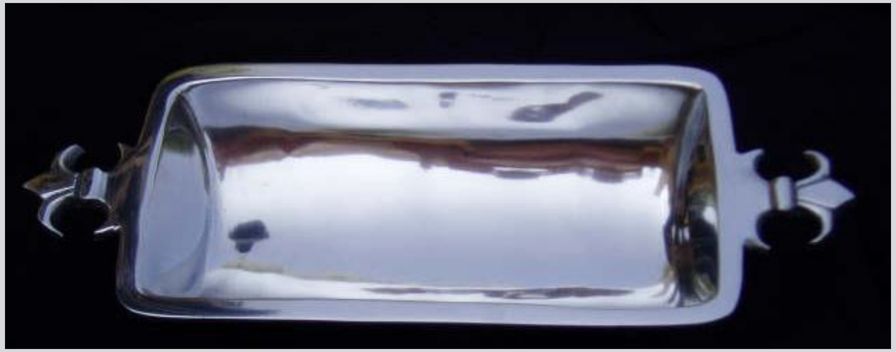
Table.- Aluminium Master Alloys.

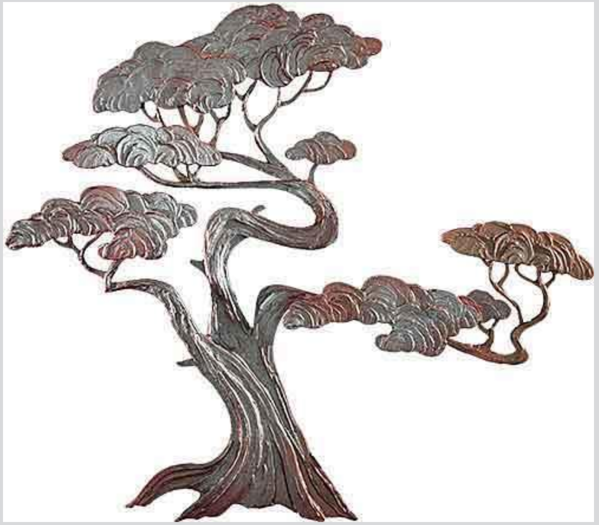
Master Alloy Aluminium -	Element Composition	Nominal	Color Code	AA Designation	CEN Designation
antimony	Sb	10%	white / yellow	-	95100
boron	B	3% 4% 5% or 8%	1 yellow stripe 2 yellow stripes 3 yellow stripes yellow / black	H2203 H2204 H2217 -	90500 90502 90504 -
bismuth	Bi	3 or 8%	purple / yellow	H2003, H2016	98300 / -
calcium	Ca	10%	white / orange	H2009	92000
chromium	Cr	10% 20%	1 purple stripe 2 purple stripes	H2910 H2920	92402 92404, 92405
cobalt	Co	10%	orange / light blue	H2006	92700
copper	Cu	33% 50 or 54%	2 orange stripes 3 orange stripes	H2132 H2154 (54%)	92900, 92901 92902, 92903 (50%)
iron	Fe	10% or 20%	black / brown black / orange	- H2820	92600, 92601 92602
magnesium	Mg	10% 20, 25% or 50%	white / black white / purple 2 white / 2 purple stripes	- - / H2010 H2011	91200 91202 / - 91204
manganese	Mn	10% or 25%	brown / white brown	- H2425	92500, 92501 -
nickel	Ni	10% or 20%	grey 2 grey stripes	H2500 H2501	92800 92802
silicon	Si	20%, 36% or 50%	white 2 white stripes	H2302 (36%) H2350	91400, 91401 (20%) 91402, 91403
strontium	Sr	3.5% 10% 12% or 15%	light blue 2 light blue stripes 3 light blue stripes 2 light blue stripes / 1 orange stripe	H2012 H2007 - -	93800 93804 - -
strontium-silicon	Sr-Si	10% Sr - 14% Si	light blue / white	H2700	-
titanium	Ti	6% or 10%	red red / black	H2006 H2210	92202 92204, 92205
vanadium	V	5 or 10%	black	H2605 / -	- / -
zirconium	Zr	10% or 15%	3 dark blue stripes dark blue / red	H2600 H2615	94002, 94003 94004
zirconium-vanadium	Zr-V	3% Zr - 2% V	dark blue / black	H2632	-

Piezas coladas artísticas base aluminio


5534
Maple Ave


CALIFORNIA
2005



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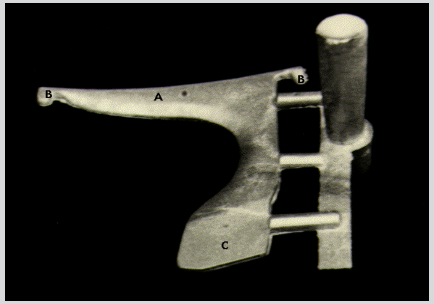
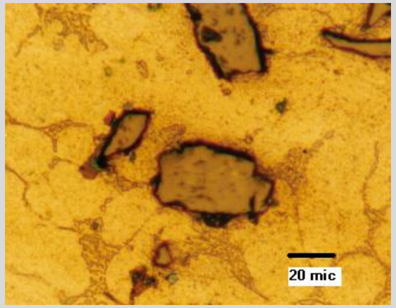
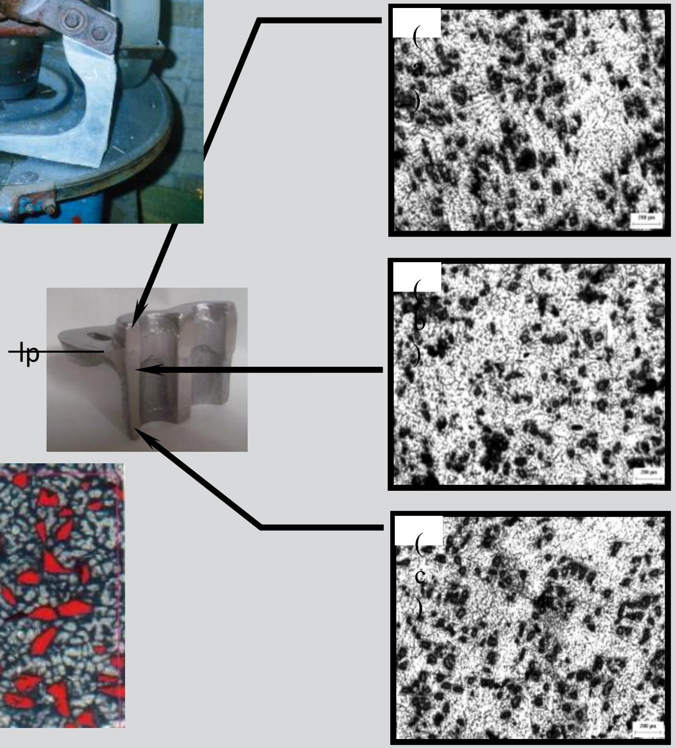
Compositos colados de matriz base Al ligera (AlCMMC´s)

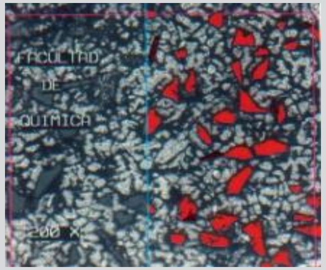
Propiedades intermedias entre la matriz y el reforzante (cermico)





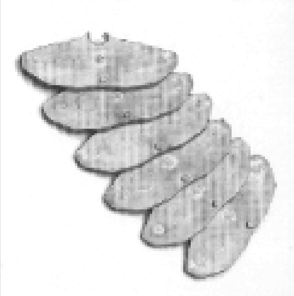
- **Manufactura de compositos (variables), caracterización (microestructura y propiedades), propiedades de fundición, efecto de refinadores de grano y modificadores, análisis térmico, estudios interfaciales, fabricación de piezas prototipo**

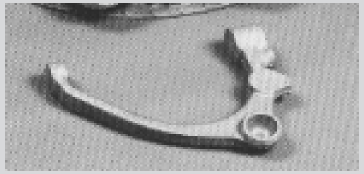


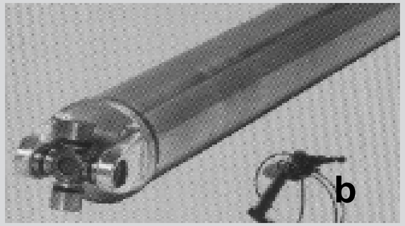


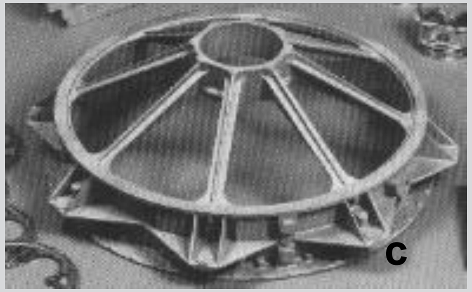
Aplicaciones de AlCMMC´s

AUTOMOTRIZ

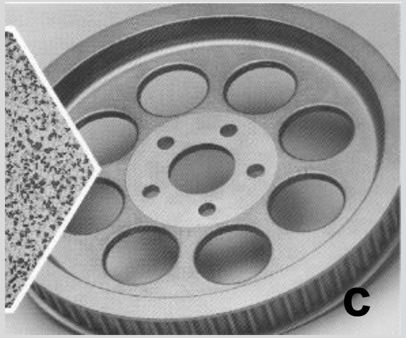








AERONÁUTICA

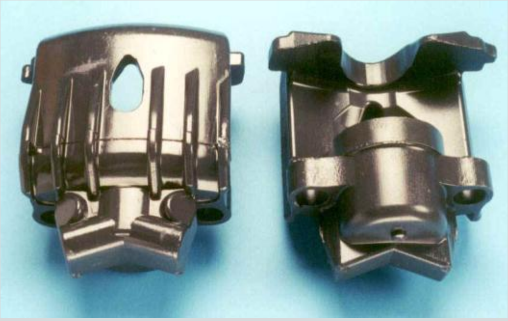


INDUSTRIAL

DEPORTIVA

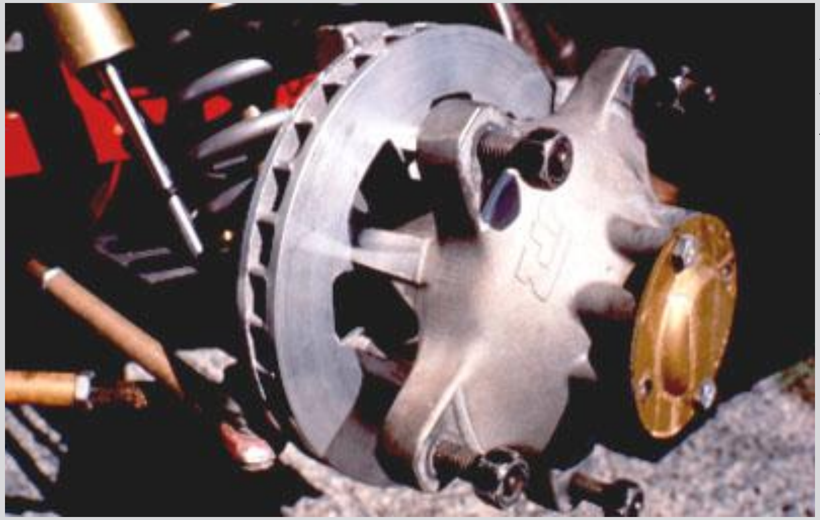
Apilicaciones particulares

Biela fabricada de Aleación base Al-Al_2O_3p, sometido a 3 000 000 de ciclos de fatiga. El peso de la pieza es de 170 gr. Comparado con los 292 gr de la pieza original de acero, representa un ahorro del 42 % en peso.



Aluminum Oxide Reinforced Al Brake Calipers. Prototipo de 54 mm. Peso de 1100 gr, comparado contra los 2300 gr. de la pieza original de hierro dúctil. Representa un ahorro de 52 % en peso, sin incrementar el volumen del nuevo diseño

Brazo de tracción de bicicleta, composito de matriz de Al reforzado con carburo de boro (BC)



Discos de freno de doble ventilación

Driveshafts

The standard of acceptability for aluminum drive shafts has been raised with the introduction of the Mark Williams composite aluminum drive shaft. The new aluminum shaft, which is produced in-house, features advanced Duralcan material. This material contains aluminum oxide particulate that increase the yield strength by 28% and most importantly, the modules of elasticity by 41%. This in turn increased the critical shaft speed, (the RPM at which the shaft will go into harmonic vibration and risks self destruction). There is also a reduction of amount of torsional wind-up, that can have a profound improvement on reaction times. The increased strength of the material allows us to build a lighter shaft than was previously available. The special MW manufactured weld yokes are produced from aluminum alloy that is 30% stronger than that of the competitors commonly used 6061 alloy. The MW attention to detail is evident with the provision for balancing weights that attach the weld yoke rather than to the tube. Long delivery times are a thing of the past, normal delivery time is now 2-5 days.

GUÍA PARA CAJA DE MOLDEO

Proceso: fundición en molde de arena en verde

Material: matriz A356(Al-7Si)-10 % vol SiCp (38 micras)

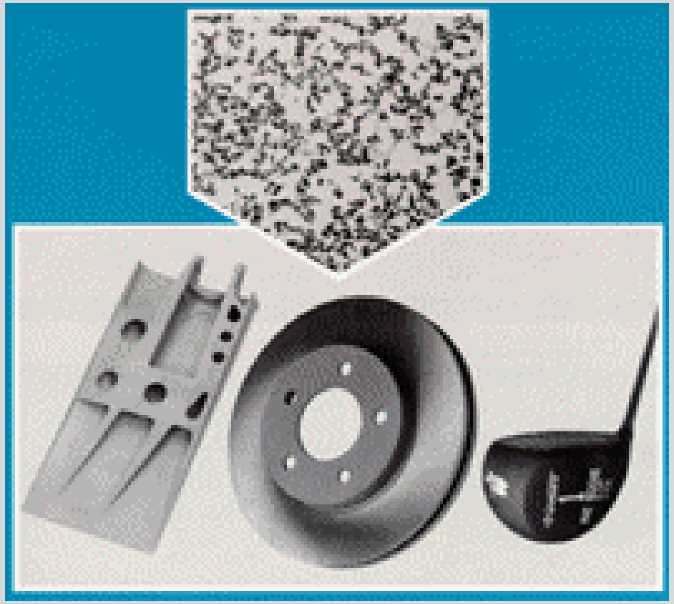
Sistema 1

Sistema 2

Sistema 3

Sistema 4

OTRAS APLICACIONES



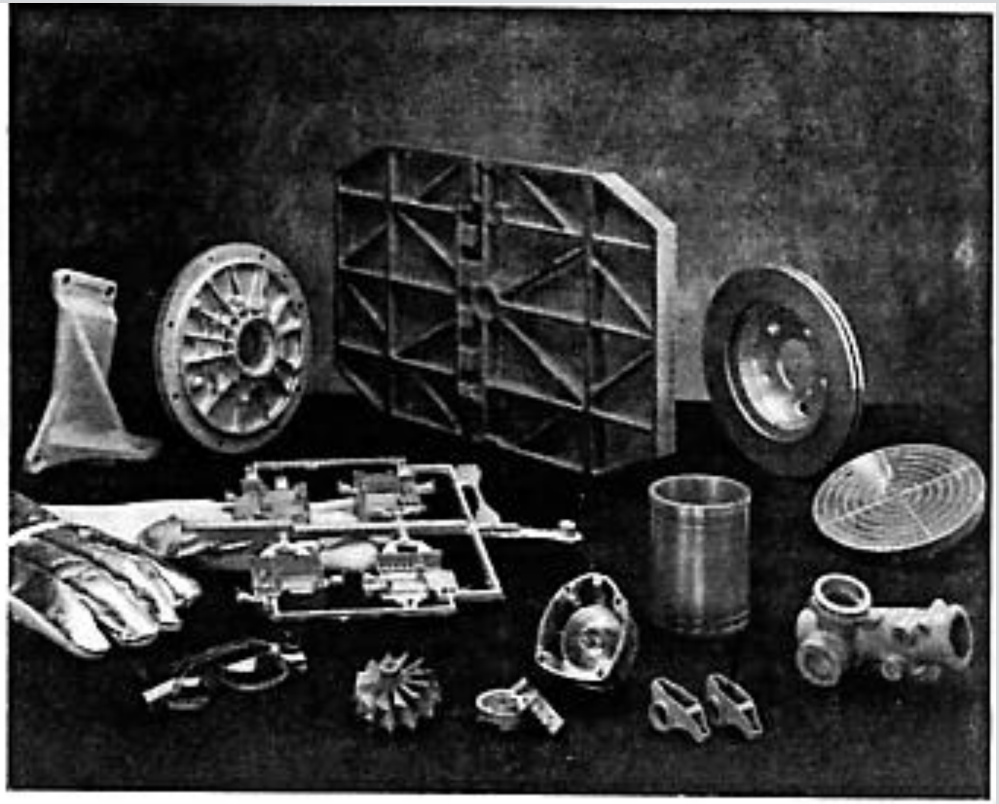


Fig. 10. Photo of cast products. Large stage in background is used for imaging equipment. Parts were produced by investment shell, sand and diecasting processes.