

## **A portrait of aluminium, metal of dream and modernity**

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### **Abstract**

Beyond its technical and commercial aspects, aluminium can be regarded from a cultural viewpoint as a metal of dream and modernity. Contrary to other ordinary metals, which were known in very ancient times, aluminium was just a dream of the chemists before it was discovered in the midst of the nineteenth century. As it was produced by way of a very costly chemical process, it was considered at first as a semi-precious metal and mainly used in jewellery. Then, with the electrolytic process, the production cost was drastically decreased and aluminium became an ordinary metal. But during World War I, it was still a matter of dream and modernity - the dream in the trenches, where the soldiers used to collect aluminium parts of shells to make various objects, such as rings for their beloved wives - and the modernity with the first aluminium military airplanes. At that time aluminium was a metal of dread as well as a metal of dream and love. Aluminium shaped the twentieth century with its modern applications in transportation, construction and households. But it remains a metal of dream with iconic creations as the Paco Rabanne's dress, the Stark's Juicy Salif or the comet lander Philae.

**Keywords:** Aluminium history ; aluminium applications.

### **1. Foreword**

After having worked for 30 years in the aluminium group of Pechiney as production superintendent, plant manager, vice-president technology and overseas operations, and finally executive vice-president of the aluminium group, CEO of Aluminium Pechiney, I retired twenty years ago, and I was elected president of the Institute for the History of Aluminium (IHA), a non-profit organisation for the development of historical research on aluminium production, fabrication and applications, the preservation and promotion of heritage through collections, exhibitions and museums, as well as publications (journal, books and website) on an international scale. That is why I want to present you a vision of aluminium beyond its usual technical and commercial aspects. Curiously it was and still can be regarded as a metal of dream and also "the material of a streamlined aesthetic that came to represent modernity." [1]

### **2. Dreaming about a new metal (1754 - 1854)**

As any beautiful story, the one of aluminium begins with a legend. 50 years before Christ, Pliny the Ancient tells, in his *Historia Naturalis*, a goldsmith in Rome was able to present the emperor Tiberius with a tray made of a new metal, very light and almost shiny as silver. The goldsmith explained to the emperor he extracted this metal from raw clay. He also assured him that only the gods and himself knew how to do it. The emperor appeared very interested, but also worried due to the fact that all his gold and silver treasures could, one day, lose their value if it would be simply possible to get this shiny metal from clay. Therefore, instead of congratulating the goldsmith, he had him right away beheaded. Although it would be theoretically possible to produce aluminium from clay, as Pechiney and Alcan proved it in the seventies with the H<sup>+</sup> process, it would imply the implementation of chemical processes surely unknown in the Roman era. It took a long time until the nineteenth century to be able to see aluminium.

## 2.1. The precursors

The alum, which refers to various double sulphates of aluminium and an alkaline metal - the word itself being derived from the Latin word *alumen* - was the first aluminium ore to be used. For long it was considered as a simple and not dissociable body. It was known as a medicine in China in the thirty sixth century BC, and in Egypt, according to the Ebers papyrus, in the sixteenth century BC. Pliny the Ancient also dedicated an article describing 39 medical uses due to its astringent feature. But its most important use as “mordant” remains related to its ability to fix the dyestuffs and make them insoluble. In his work *De natura fossilium* published in 1546, the German mineralogist Georg Bauer, known as Agricola, made an inventory of the alum mines, the most important of them was La Tolfa, northwest from Rome. Ten years later, in his *De re metallica*, he described the mining processes to get alum from the alumiferous earths.

In 1754, the German chemist Sigismund Marggraf (1709-1782) managed to decompose alum by calcination. He isolated the *pure clay* or the *earth of alum*, which is nothing else than alumina, the aluminium oxide. In turn, this one was initially considered as a simple body. Théodore Baron, a French physician, was the first one who asserted to be convinced the earth of alum hid a metal. In 1760, he tried in vain to decompose it, but he wrote: “*I think it not too adventurous to predict a day will come when the metallic nature of the base of alum will be incontestably proven.*” [2] Thus he was on that way the Lavoisier’s precursor, this one having put forward, in 1787, the more general assumption that earths could not be only simple bodies. With Robert Guyton de Morveau (1737 - 1816), a French magistrate and chemist, he renewed the chemical nomenclature of that time, and the *alum earth* became *alumina*.

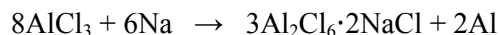
In 1807, the British chemist and physicist Humphrey Davy (1778 - 1829), using the Volta battery, succeeded in isolating sodium and potassium, but alumina was resistant to this processing. He wrote: “*Had I been fortunate enough to isolate the metal after which I sought, I would have given it the name aluminum.*” [3]. This name is derived from *alumen* (alum). But the new metals being rather denominated from their oxide, it became, a few years later, *aluminium*, from alumina, instead of aluminum.

The Danish physicist and chemist Hans Christian Oersted (1777 - 1851) thought of using the aluminium chloride as a medium. In 1825, he made its synthesis by reaction of chlorine with a mixture of alumina and coal. Then he tried to reduce it with an amalgam of potassium. After calcination, he obtained a powder containing perhaps some aluminium, but with too many impurities so that he was unable to determine its properties.

These experiments were repeated in 1827 by a German chemist, Friedrich Wöhler (1800-1881) who replaced the potassium amalgam by pure potassium and so obtained “*a grey powder which, closely examined, seems made of small metallic flakes. It is aluminium.*” [4]. But this aluminium was mixed with some impurities and especially potassium, which wrongly gave it the property to be attacked by using boiling water. In 1845 he obtained some bigger particles, which allowed him to determine its density, but they were still impure and attacked by boiling water.

## 2.2. The Sainte-Claire Deville process

Finally, in 1854, the French chemist Henri Sainte-Claire Deville (1818-1881) resumed the Wöhler's experiments in his laboratory at the Ecole Normale Supérieure in Paris and replaced potassium by sodium. At about 700 °C the aluminium chloride in excess combines with sodium to form some aluminium-sodium double chloride in liquid state, in which the excess aluminium gathers forming big globules:



At the time he was perfecting the chemical process, Deville looked for the possibility of producing aluminium through electrolysis of the same double chloride by using a battery. The German physicist and chemist Robert Bunsen (1811 - 1899) reached the same result at the same time. Indeed, while Deville was describing his two processes, the chemical and the electrolytic ones, at the Academy of Science on August 14, 1854, the Bunsen electrolytic process was just published a few weeks before on July 9, 1854, in the Poggendorff's Annalen. By the way, the first aluminium ingot, which was displayed to the Academy on March 20, 1854, was of electrolytic origin, while Jean-Baptiste Dumas presented the first chemical aluminium ingot there on June 18, 1855. At the World Exhibition in 1855 in Paris, a few small aluminium ingots were also displayed, with some sodium and aluminium chloride samples, in the Panorama Rotunda next to the crown jewels.

*“My first thought was I had laid my hands on this intermediate metal which would find its place in man's uses and needs when we would find the way of taking it out of the chemists' laboratory and putting it in the industry.” [5].*

### **3. The intermediate metal, between dream and everyday life (1854 - 1914)**

For 30 years, from 1860 up to 1890, the total production was only about 45 tonnes, the price having, in the same time, progressively decreased from 100 to 60 F/kg. In the very first years (1855 - 1860), the price remaining at the level of silver, its applications were limited to jewellery and silversmith's trade. It was the dream of a precious metal. Some items became famous:

- The baby-rattle of the Imperial Prince (Napoleon III's son) created in 1856 by Honoré Bourdoncle in aluminium combined with gold, diamond emerald and coral.
- The parade helmet of Prince Ferdinand of Denmark in 1859, and the French dragon officer's helmet (1872) (Figure 1)

There was aluminium in jewels (Figure 2) as well as in optical appliances as opera glasses and scientific instruments such as precision scales. Later on, its price gradually decreasing, it was used in various household applications, mostly tableware in aluminium bronze, a copper alloy with 5 to 15 % aluminium.

At that time, it was really an intermediate metal between jewellery and household appliances. Many ordinary objects were manufactured in chemical aluminium, but their large-scale development had to wait for the production of low cost aluminium through electrolysis, when the Hall-Héroult process was perfected and industrially used in the very last years of the 19<sup>th</sup> century. A symbolic creation of that time was the statue of Eros, erected in 1893 at Piccadilly Circus in London, one of the first statues in aluminium. (Figure 3).



**Figure 1. Dragon officer's helmet (1872).**  
*Jean Plateau-IHA Collection ©Gil Forent*



**Figure 2. Bracelet aluminium, vermeil and enamel (circa 1862).**  
*Jean Plateau-IHA Collection ©Gil Forent*



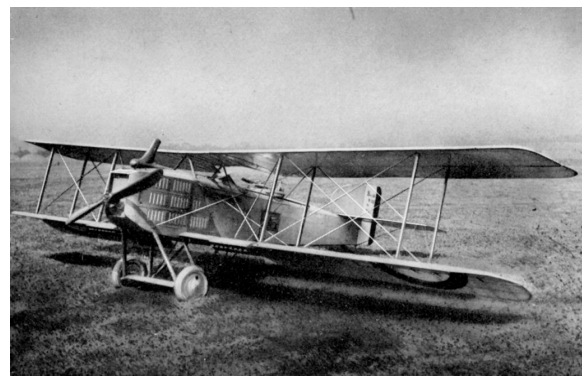
**Figure 3. The statue of Eros at Piccadilly (circa 1893).**  
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#### **4. Metal of dread, metal of love during World War I (1914 - 1918)**

The First World War marked a turning point in the use of aluminium for military purposes. In 1900, the first aluminium airship was a Zeppelin with a rigid structure in aluminium profiles (Figure 4). During the war, a new high resistant alloy, the Duralumin, was used for the first metal military aircrafts, the Junker J1 in Germany (1915) and the Breguet XIV (Figure 5) in France (1916). They were mainly bombers, planes of dread and horror. There were also aluminium pieces in the German shells.



**Figure 4. The German Zeppelin LZ**



**Figure 5. The Breguet XIV.**

at Berlin-Johannistel, 1913.

*Revue de l'aluminium*, n°180, 1951/09

In order to escape the boredom and horror of the conflict, the soldiers used to leave the trenches to collect shells following an enemy fire. Then they would remelt the aluminium parts to make objects as inkpots, snuffboxes, napkin rings and, more often, rings for their beloved wives and girlfriends (Figure 6). They created small workshops with limited tools. A famous French poet, Guillaume Apollinaire (1880 - 1918), described the operation in some letters:

*“For to make in one’s spare time, my dear friend, rings  
One takes from these shells all the aluminium  
Which is filed down every day while telling jokes  
By servants who are idle up to a maximum.”* [6].

and,

*“Your ring was melted in a mould made in a potato... and finished off with a file.  
It’s not difficult as aluminium is easy to work.”* [7].



**Figure 6. Rings made by soldiers.**

*Aluminium Passion.*

*Jean Plateau-IHA Collection ©Gil Forent*

In a letter to his girlfriend Lou, he wrote:

*“For I want to sculpt for you a very pure ring in a metal of dread.”* [8].

And when he was dreaming of his fiancée, Madeleine, he sent her a letter with a striking portrait of the metal:

*“You are waiting for me with on your fingers  
Poor rings made from aluminium  
Pale like the absence and tender like the memory,  
Metal of our love, metal alike to dawn.”* [9].

## 5. The light metal of the modern life

Due to its specific features, lightness, thermal and electrical conductivity, stainless metal, reflecting power, and its ability to be alloyed with other elements such as silicon, copper, magnesium, manganese, aluminium shaped the twentieth century in all sectors of the modern life: household, packaging, transportation and building. It is in particular the metal of design as well as science and technology.

### 5.1. The metal of movement

During the 20th century, aluminium was particularly the metal of dream and modernity in the different fields of movement. The dream of high speed and space. The modernity of high technology for speed, safety and comfort.

After the success of the first aluminium military aircrafts of the First World War, the aircraft industry knew fabulous development from Charles Lindbergh's Spirit of Saint Louis in 1927 (Figure 7) to the recent Boeing 787 Dreamliner and the Airbus A 380 (Figure 8). It owed much of this development to aluminium, thanks to a specially strong, hard and lightweight alloy, the duralumin, with copper, magnesium and manganese, discovered in 1906 and patented in 1909 by Alfred Wilm, a German metallurgist. Then, in the strong competition with other materials such as plastic-carbon composites, the aluminium industry has been developing new alloys. The last one, airware, an aluminium-lithium alloy, seems particularly promising.



**Figure 7. The Spirit of Saint Louis (1927).**



© AIRBUS S.A.S. 2005 \_ photo by e'm company / H. GOUSSE

**Figure 8. The Airbus A 380 (2005).**

Aluminium was confined to minor uses in car production, because it proved difficult to assemble, weld and paint. But the ecologic requirements are reversing this trend in consideration of the specific properties of the light metal and its ability to be easily recycled. The weight of aluminium per car increased from 50 kg in 1990 to 80 kg in 2000 and 150 kg today. It is the metal for the car of the future, consuming less energy, emitting less carbon oxide and being more recycled. One of the most famous cars is the A8 Audi limousine (1994), with an all-aluminium body, made of seven different aircraft-grade alloys, which is 40 % lighter than a comparable steel body (Figure 10).



**Figure 9.**  
**La Jamais Contente (1899).**  
*Jean-Albert Grégoire -  
IHA Collection*

©Photo Hutin



**Figure 10.**  
**The Audi A8 (1994).**

The same considerations are valid for boats and trains. Moreover, boats being subject to corrosion by seawater, satisfactory solutions were found with highly resistant alloys and galvanic protection systems. As far as trains are concerned, the Japanese Bullet Train Shinkansen, and the French Very High Speed TGV, were initially built of steel. But then aluminium alloys were extensively used for important parts of the railcar, in order to carry more passengers with the same trains (Duplex) (Figure 11), and crash tests having confirmed its high shock resistance.



**Figure 11. The Duplex TGV.**

## **5.2. The metal of space**

Since the famous Jules Verne's book "*From the earth to the moon*" published in 1865, the conquest of space was a fabulous dream, which incited humans to gigantic research programs. And, as far as materials were concerned, aluminium alloys took an important part in these ventures.

On October 4, 1957, Sputnik 1, an 84 kg ball of aluminium left the earth's atmosphere, opening space exploration. And on July 20, 1969, Jules Verne's dream came true when the two Apollo 11 astronauts put their feet on the moon. One of them, Buzz Aldrin, deployed a scientific instrument, the SWC (Solar Wind Composition) panel, in the form of an aluminium sheet.

More recently, on November 12, 2014, Philae, the lander of the space probe Rosetta, reached the surface of the Chury comet (Figure 12). Its body is made of carbon fibre with aluminium cellular panels. In this case we are, with aluminium, at the top of dream and modernity.



**Figure 12. The space lander Philae.**

### **5.3. The metal of building**

Since the apex of the Washington Monument in 1885 and the roof of the San Gioacchino church in Roma in 1897, aluminium progressively appeared in the architectural landscape. The main steps were:

- The Postal Office Savings Bank in Vienna built from 1903 to 1912 by Otto Wagner (1841 - 1918), a famous Austrian architect of the “Vienna Secession” (Figures 13a and 13b).
- After World War I, the Bauhaus movement in Germany, with architects Walter Gropius and Ludwig Mies van der Rohe.
- After World War II, new construction systems, using prefabricated metallic elements, were developed with various aluminium parts for roofing and siding, in particular the new building technique of the curtain wall used in Alcoa Head Office in Pittsburgh in 1950.

The trend was to use the advanced car and aircraft engineering techniques for prefabricated aluminium houses. The two main projects were the Dymaxion House of Richard Buckminster Fuller and La Maison Tropicale (the tropical house) of the French designer and architect Jean Prouvé.

Aluminium allowed the architects to dream of aerial profiles beyond the conventional construction. As Marcel Breuer, a leader of the Bauhaus, said: *“We have developed architecture from the pyramid, which is based on gravity, to the architecture of the airplane, which totally defeats gravity.”*[10].

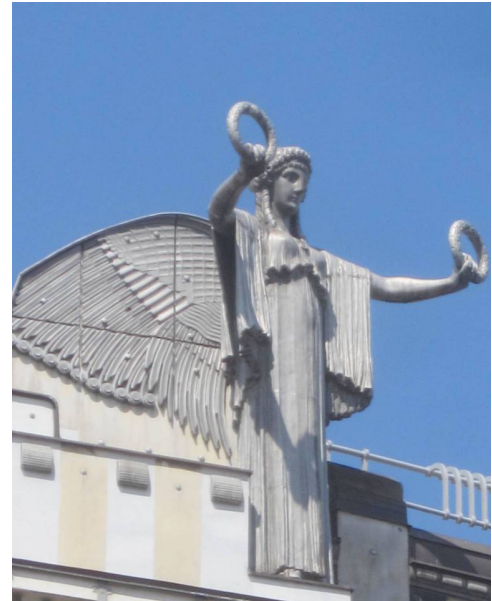
More recently, we can notice two outstanding examples of dream and modernity:

- Designed by the architect Daniel Libeskind, the Imperial War Museum North in Manchester is a striking aluminium clad building.
- And in Paris, the new concert hall, La Philharmonie takes the forms of an aluminium hill, which rises up in a series of tilted plates, clad with interlocking bird-shaped aluminium tiles (Figures 14a and 14b).

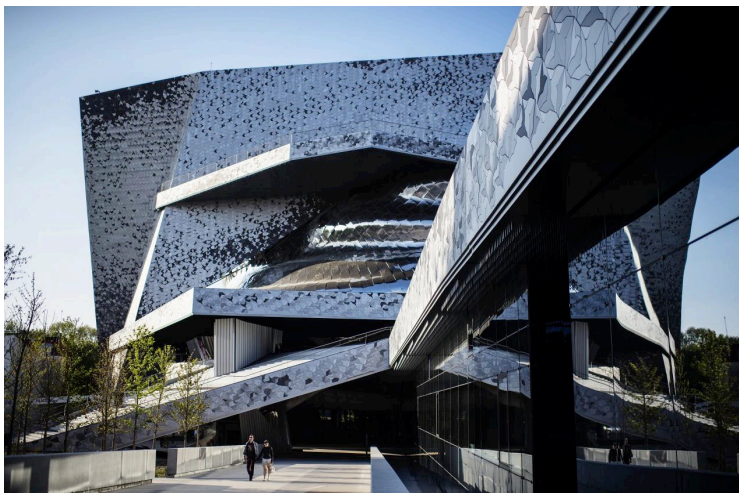
As Ludwig Mies van der Rohe used to say: *"The danger with aluminium is that you can do whatever you like with it; it doesn't really have any limitation."*[10]



**Figure 13a. The Post Office Savings Bank in Vienna (1906).**  
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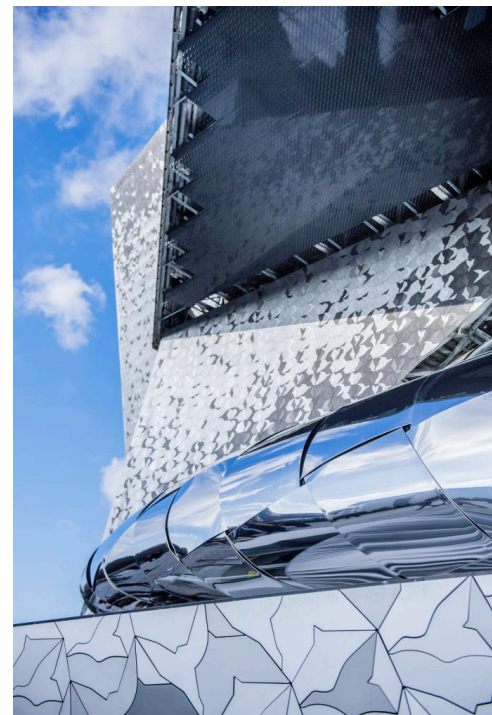


**Figure 13b. Statue on the roof.**  
©Maurice Laparra



**Figure 14a. The Philharmonie, outside overview.**

*The Philharmonie in Paris (2015) ©William Beaucardet /Philharmonie de Paris*



**Figure 14b. The Philharmonie, outside detail.**

#### 5.4. The metal of design

Aluminium is known as the metal of everyday life in various household applications, as kitchen utensils and furniture. But it also appears in this field as a metal of dream with various emblematic objects created by famous designers: chairs, tables, lamps, even kitchenware. All around the world, designers explored aluminium ability to address functional and aesthetic issues, from the Arts and Crafts movement at the end of the 19th century to Streamline (1925 - 1960) and postmodern creations. In IHA's collections, we retain iconic artefacts such as:

- Paco Rabanne: several dresses made of rectangles and squares of aluminium sheet (Figure 15)  
*"Architecture renounced stone, paintings canvas, sculpture marble. I, in turn, engulfed in the flight of a changing society, abandoned my needle and thread for my pliers and blow-torch."* [11].
- Rudolf Reinhart: Cockerel to commemorate the centenary of aluminium (1954) (Figure 16).
- Philippe Stark: the lemon squeezer "Juicy Salif" (Figure 17), and the Hot Bertaa kettle (Figure 18), both made by the Italian firm Alessi. It is more beautiful to see than easy to use. As Stark said himself, *"When I create, I am less interested by the technical or commercial aspects than the research of fantasy."*

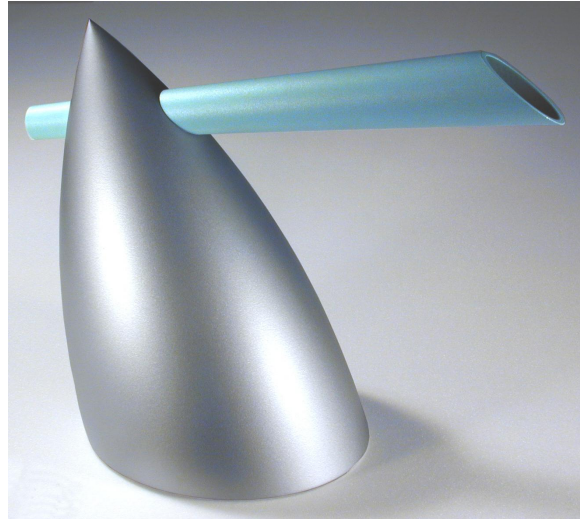
Among other designers having used aluminium, we can notice:

- Marcel Breuer: side chairs (1932),
- Russel Wright: kitchen utensils (1932-35),
- Hans Coray: Landi chairs (1938),
- Marc Newson: Lockheed Lounge (1985).

A French painter, Olivier Debré, pointed out that: *"Aluminium has the elegance of an immaterial strength. It is the right formalization of our dreams."*



**Figure 15. Paco Rabanne aluminium dress. Figure 16. Rudolf Reinhart. Cockerel to commemorate the centenary of aluminium (1954).**  
*Jean Plateau-IHA Collection ©Gil Forent*



**Figure 17. The Juicy Salif citrus squeezer (1990). Figure 18. The Hot Bertaa kettle (1989).**  
*Philippe Starck. Jean Plateau-IHA Collection ©Gil Forent*

One may also find aluminium in unexpected fields like postcards (Figure 19), from the beginning of the 20<sup>th</sup> century, or tribal art (Figure 20)



**Figure 19. Aluminised postcard (1904).**

*Jean Plateau-IHA Collection ©Gil Forent*



**Figure 20. Senoufo statue.**

## 6. Nostalgia for the future

I would like to conclude this paper by addressing a call to the whole aluminium community: Help the Institute for the History of Aluminium to pursue its unique, unrivalled approach to preserve and enhance aluminium heritage.

The light metal has become everybody's metal. Its various applications in different times and different places tell a large array of stories which belong to our common culture. It is part of our memories as well as it shapes our future.

This is why aluminium heritage preservation deserves an important continuous effort from all of us. IHA opened the way 30 years ago. It is now asked for managing research programs, providing information to many different audiences: education, industry, culture.

It would be deeply exciting for us to share our know-how, to broaden our collections and network with all the aluminium people, companies, organizations. Heritage may reveal itself as a major part of our present and future identity.

*“Yet aluminum cannot help but embody the optimism that accompanies a reorientation toward a better, cleaner, simpler world. It is the material that best expresses nostalgia for the future.”*[12.]

## 7. Acknowledgements

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### Final note:

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