



An innovative program to make science education and careers in raw materials attractive for youngster

Raw Matters Ambassadors at Schools **RM@Schools**

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National Research Council (CNR)

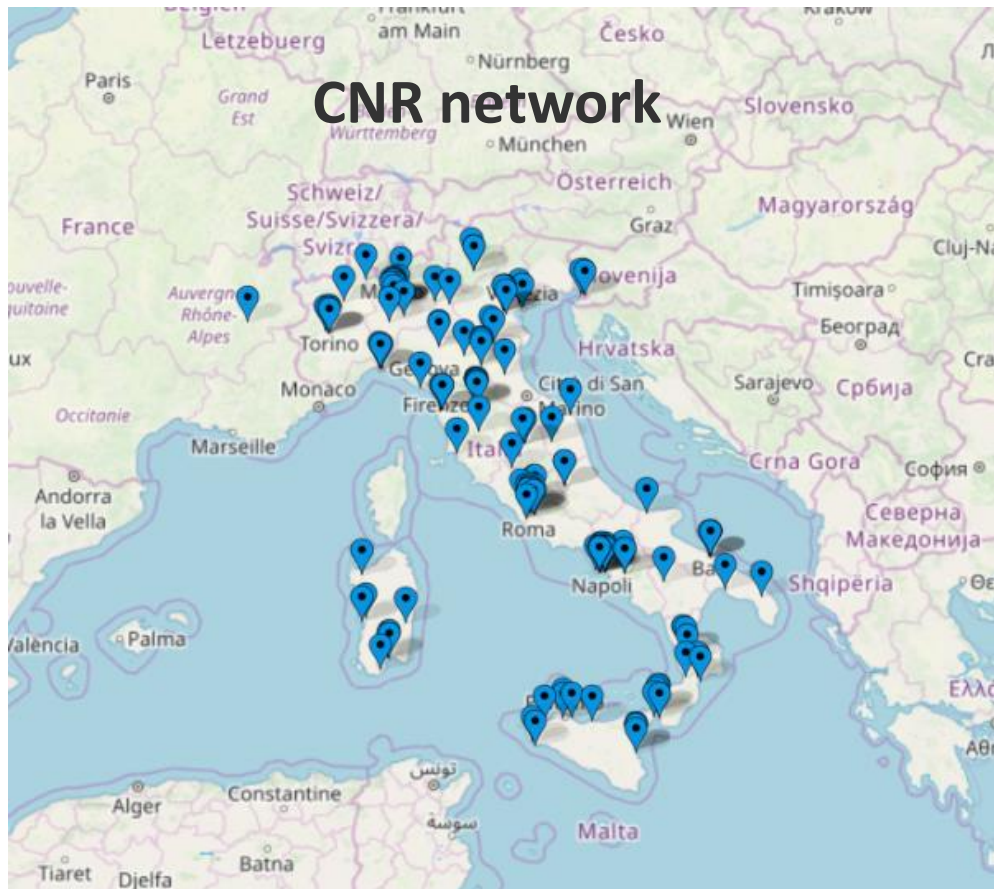
Italy (IT)_ Bologna

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National Research Council of Italy

National Research Council of Italy



Where is Bologna?



Some curiosities ... Bologna is also the hometown of:



G. Marconi



Ducati



Lamborghini



Ferrari (MO)



... and "Ragù Bolognese"

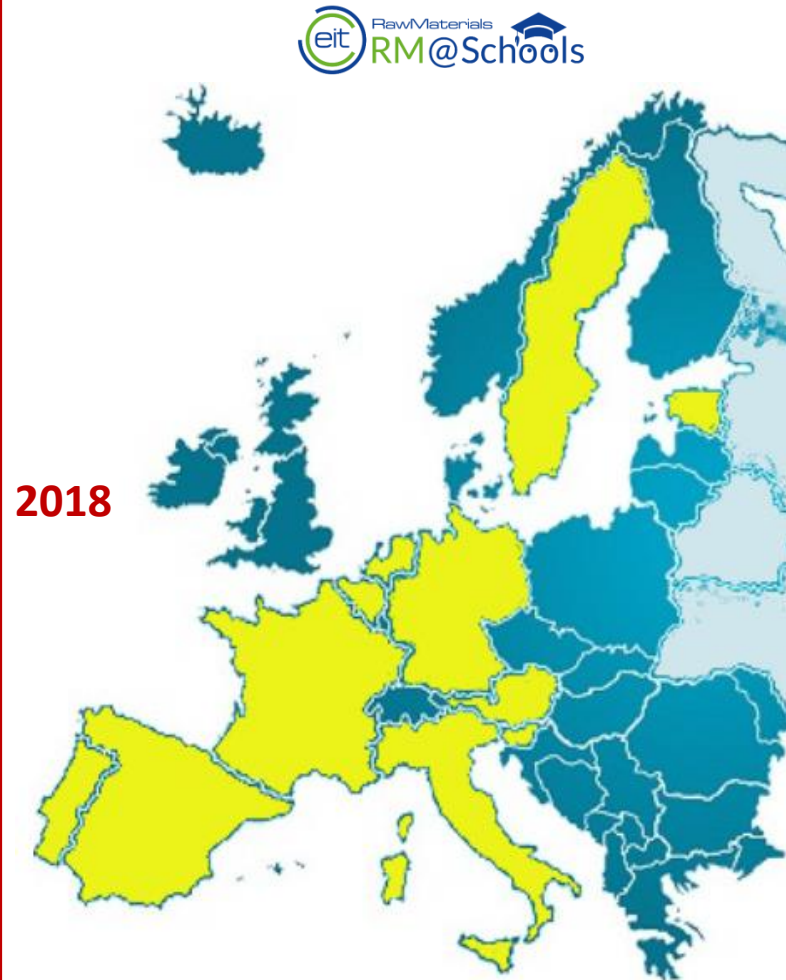
Raw MatTERS Ambassadors at Schools

An innovative program to promote a wide dissemination action on RM-related topics in School and Society thanks to the strategic partnership between Research, School, and Industry.



21 partners from 13 EU countries with complementary expertises in the field of RM and education:

- | | |
|---|-------------|
| <ol style="list-style-type: none"> (1) CNR (project coordinator) -Italy (2) Stichting Wetsus - The Netherlands (3) University of Liege - Belgium (4) Technische Universität Clausthal - Germany (5) Universidad Politecnica de Madrid - Spain (6) Bay Zoltán Nonprofit Ltd. - Hungary | 2016 |
| <ol style="list-style-type: none"> (7) Fraunhofer Institute - Germany (8) Montan-Universitaet Leoben - Austria | 2017 |
| <ol style="list-style-type: none"> (9) KTH - Royal Institute of Technology – Portugal (10) Fundação para a Ciência e a Tecnologia- (11) Politecnico di Milano -Italy (12) RWTH Aachen University - Germany (13) Tallinn University of Technology- Estonia (14) University of Milano- Bicocca -Italy (15) University of Bologna -Italy (16) Geological Survey of Slovenia – Slovenia (17) Geological Survey of Sweden - Sweden (18) ECODOM S.r.l– Italy (19) Commissariat à l'énergie atomique et aux énergies alternatives CEA – France (20) ASTER– Italy (21) Aalto Univeristy - Finland | 2018 |



The Local Networks between research institutes, secondary schools, and companies will be set up in all 13 EU countries with the aim to stimulate schools and companies to get in touch each another.





RM@Schools Network:

- 54 Schools
- 22 Companies
- 21 Universities
& Research Centers

Related numbers

year	2018	13 Countries 54 Schools	1300 RM@Schools Students 56 Classes	41 RM@Schools Public Events <i>(planned 10)</i>	7000 people Generic public	7 Teacher Workshops 9 Students workshops
	2017	8 Countries 20 schools	750 RM@Schools Students 34 Classes	20 RM@Schools Events <i>(planned 8)</i>	3500 Public	
	2016	6 Countries 12 Schools	600 RM@schools Students 24 Classes	1 RM@Schools Events	500 public	



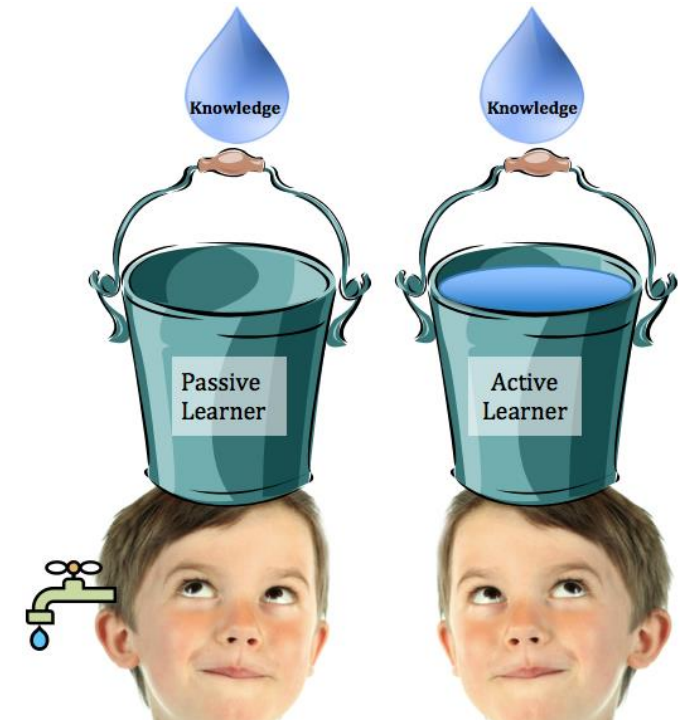
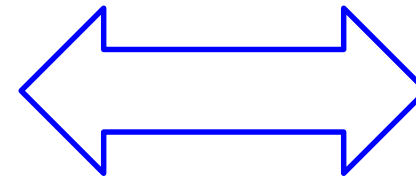
Main Actors:

Students, teachers and RM-experts



Idea:

RM@Schools proposes to schools an active learning by involving students in experiments (educational toolkits) and in communication activities



All students are introduced into RM-related topics by RM Ambassadors (at schools, research centers, etc...) and then stimulated to become (new) young RM ambassador (knowledge propagation)



Target groups:

10 – 19 yrs students

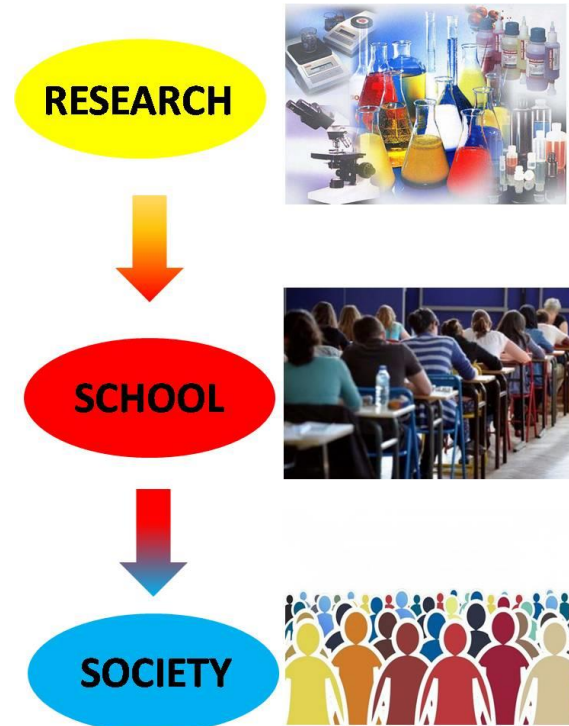
*They are involved in a **lesson/experiment (active learning)** and **science dissemination activities** by creating **communication products (2 languages)** related to Raw Materials (age: 14 – 19)*

School Teachers

RM@Schools program offers innovative tools for teachers to educate their students about RM

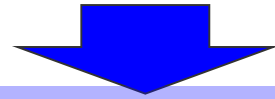
Generic Public

*Pupils becomes **active players** to share knowledge/concepts into society*



in order to transform the classes *into a lab*

16 experimental toolkits developed to support the future RM Ambassadors



Inserted in Learning Pathways

Geology & Mining

1. Geology games
2. From minerals' discovery to returning to the land in the natural state
3. Plant4RM
4. Extraction of metals from water
5. Metallurgy of copper
6. Simple experiments on RM properties

Recycling & Circular Economy

7. Cation exchanger
8. Deinking
9. Dismantling of mobile phone
10. Metal Separation
11. Recycling of Aluminium
12. Renewable keratin wastes for metal mining
13. P recovery

Substitution

14. RM materials substitution in electronic, optoelectronic ...
15. Doodles Toolkits magnetic Materials
16. Hands-on Experiments on fluorescence,



Every toolkit should be supported by:

- Popular description of the activity: shown on our Website
- Introduction of the scientific topic: power point presentation, videos, ect. useful for explaining the basic concepts in this field (to help teachers to introduce scientific elements).
- Explanation of the experimental activity

Tutorial video, experimental protocols, etc



... after a specific learning pathway ...

How can students become ambassadors of science ?

Possible strategies:

- **Preparation of dissemination products/materials**
 - **Peer-education**
 - **Participation to public events**



1) Dissemination Products/Materials:

- “Easier” way
- Very effective tools
- Space to creativity
- Class or sub-groups
- Direct interactions
with students/teachers

POSTERS



10-12 YEARS

3D MODEL (+ descriptions)



Front page

2019

RARE EARTHS CALENDAR



Introduction

WHAT ARE RAW MATERIALS?

RAW MATERIALS ARE THE BASIC MATTERS OF WHICH ALL OF THE GOODS AT OUR DISPOSAL ARE MADE OF. IN PARTICULAR, THIS CALENDAR WILL FOCUS ON *RARE EARTHS*, NAMELY VERY USEFUL METALS FOR THE GLOBAL ECONOMY, YET VERY RARE AND LITTLE ABUNDANT ON OUR PLANET.

WHERE CAN THEY BE FOUND?

CHINA IS THE MAJOR SUPPLIER OF CRITICAL RAW MATERIALS, ACCOUNTING FOR 70% OF THEIR GLOBAL SUPPLY AND 62% OF THEIR SUPPLY TO THE EU (E.G. RARE EARTH ELEMENTS, MAGNESIUM, ANTIMONY, NATURAL GRAPHITE, ETC.). BRAZIL (NIOBIUM), USA (BERYLLIUM AND HELIUM), RUSSIA (PALLADIUM) AND SOUTH AFRICA (IRIDIUM, PLATINUM, RHODIUM AND RUTHENIUM) ARE ALSO IMPORTANT PRODUCERS OF CRITICAL RAW MATERIALS.

WHY IS IT IMPORTANT TO KNOW THEM?

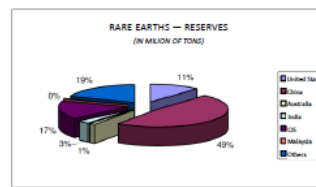
RAW MATERIALS ARE ESSENTIAL FOR THE SUSTAINABLE FUNCTIONING OF MODERN SOCIETIES. ACCESS TO AND AFFORDABILITY OF MINERAL RAW MATERIALS ARE CRUCIAL FOR THE SOUND FUNCTIONING OF THE EU'S ECONOMY. SECTORS SUCH AS CONSTRUCTION, CHEMICALS, AUTOMOTIVE, AEROSPACE, WHICH PROVIDE A TOTAL VALUE ADDED OF € 1324 BILLION AND EMPLOYMENT FOR SOME 30 MILLION PEOPLE, ALL DEPEND ON ACCESS TO RAW MATERIALS.

WHY DID WE MAKE THIS CALENDAR?

WE STUDENTS OF *LICEO N. COPERNICO* (SCIENTIFIC HIGH SCHOOL), CLASS 3A, MADE THIS CALENDAR AS A WORK EXPERIENCE PROJECT PROPOSED BY BOLOGNA CNR (NATIONAL RESEARCH COUNCIL), IN ORDER TO MAKE AS MANY PEOPLE AS POSSIBLE AWARE OF THIS PROBLEM. IN FACT, EACH OF US SHOULD RECYCLE HOUSEHOLD APPLIANCES TO MAKE THE REUSE OF RAW MATERIALS AND *RARE EARTHS* POSSIBLE, AS THEY ARE CONTAINED IN THINGS WE DAILY MAKE USE OF.



THE STUDENTS OF *LICEO N. COPERNICO*, CLASS 3^A, BOLOGNA



Reference: ICF data processing, on USGS data, 2010

Typical layout

MAY

NEODYMIUM



Neodymium is a silvery-looking metal that belongs to the Lanthanides group; it is present in many alloys. It is never found in nature in the native state, but it is found in minerals, including monazite and bastnaesite; therefore its separation from the other *Rare Earths* is quite difficult. After Cerium, **Neodymium** is the most abundant element of the *Rare Earths*.

Neodymium powder and its salts are very irritating to eyes and mucous membranes and it can moderately irritate skin. Inhalation of dust can cause lung embolism and damage the liver, just like other elements of the Lanthanides group.

Neodymium is mainly used as a component of a strongly magnetic alloy, used for making strong magnets. These magnets can be found in hard disks, cars, earphones, loudspeakers and wind turbines.

Neodymium is also a component of Didymium, an alloy used to colour glass, welders protective glasses and filters for astronomical observations.



MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
		1	2	3	4	5
6	7	8	9	10	11	12
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FEBRUARY

LANTHANUM



Davidite

In nature a very little amount of **Lanthanum** is available and it is usually extracted from minerals, such as monazite and bastnaesite, which are the most common ones.

Nevertheless, when we throw our household appliances, we dump **Lanthanum** into the environment and it then deposits in the soil, contaminating water and crops.

Lanthanum request increases day by day, due to its wide use in catalysis production, glass and enamel polishes, televisions, fluorescent and energy-saving lamps and camera and telescopes lenses.

Lanthanum is the metal the **Lanthanides** group is named after and it was discovered in 1838 by Swedish Carl Mosander.

It is a silvery-white, ductile, malleable and very soft metal, since it can be cut by means of a kitchen knife.

Lanthanum is particularly harmful for our health, mainly in working environment. This is due to the fact that its dust can be easily inhaled and after a long time they accumulate in our body, which is likely to cause pulmonary embolism or even lung cancer.



Camera

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
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JANUARY

PHOSPHOR



Red Phosphor

Phosphor is a non-metal of the 5th group of the periodic table that can be found in natural rocks and as white, red or black phosphorus, although its shades are slightly different, and in living cells molecules.

White **Phosphorus** is used in manufacturing industry: it is phosphorescent, explosive when in contact with air and a deadly poison.

Red **Phosphorus** has a spectrum of colours from purple to orange, due to its chemical structure.

Eventually, black **Phosphorus** is only produced at high pressure and it is an electricity conductor.

On Earth **Phosphor** can't be found as a pure element, yet only as **phosphate**, that is a **Phosphorus** atom bound to four oxygen atoms.

Phosphates are important for our body, as they represent a part of our DNA and take part to the transport of energy.

Concentrated **phosphoric acids** are widely used in agriculture as fertilizers and pesticides.



Phosphor mineral



Red phosphor

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SEPTEMBER

ERBIUM



Erbium

Erbium has no biological role, even though it has been noticed that it speeds metabolism up. It is quite hard to quantify the amount of **Erbium** contained inside the human body. The highest levels are contained in bones, while lower levels in kidney and liver.

Erbium is added to alloys containing metals such as Vanadium because it reduces their hardness, making them more workable. Thanks to its infrared light absorption property, **Erbium** is added to welding and glassblowing protective glasses.

Lastly, thanks to its pink colour, **Erbium** is used as a ceramic and glasses colourant.

Erbium, belonging to the Lanthanides group, is a soft, malleable, ductile and silvery metal.

Erbium salts are pink coloured, showing a clean light absorption in visible, ultraviolet and infrared spectrum. We cannot find **Erbium** as a free element in Nature, but we can find it inside minerals that include other *Rare Earths*.

The main minerals **Erbium** can be found in are monazite & bastnaesite, where it is present in extractable quantity, although better sources are nonexistent & expensive.

Protective glasses

Pink salts

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MARCH

CERIUM



Cerium

Cerium is the most abundant Rare Earths element on the Earth's crust.

Just like **Lanthanum**, **Cerium** is very dangerous for our health, since its dust, if inhaled, could cause pulmonary embolism; furthermore, if dispersed in the environment, it causes the same effects as **Lanthanum**.

Cerium is used in iron-aluminium alloys, in stainless steel precipitation hardening, and in permanent magnets.

Its main use is in flat-screen televisions and in energy-saving light bulbs, though.

Cerium, just like most of the elements this calendar is about, is a rare earths metal, as it is part of the Lanthanides group.

It is an iron-grey, malleable, ductile and soft metal, although it is slightly harder than lead. **Cerium** is very reactive: it can catch fire once heated up or scratched by a blade.

Oddly, in the same year, 1803, Jacob Berzelius and Wilhelm von Hisinger discovered **Cerium** in Sweden, while Martin Heinrich Klaproth in Germany.



Energy-saving light bulb



Flat-screen television

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25	26	27	28	29	30	31



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<https://it.wikipedia.org/wiki/Plutonio>

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<https://it.wikipedia.org/wiki/Praseodimio>

COVER PICTURES:

2019 PICTURE ADOBE SYSTEMS INCORPORATED®
ELEMENTS PICTURES: AUGUST SOFTWARE

DESIGNED AND MADE BY LICEO COPERNICO, BOLOGNA:

NOEMI SANTORO

ALESSANDRO BIANCHI

REA SHEHLI

CHIARA BALDAZZI

RAFFAELE MAROTTA

CHIARA MARCHESINI

DANILO MUSOLESI

ALESSANDRO JAMAL DE LUCA

FEDERICA FIORE

LEONARDO RAPPINI

MATILDE NARDI

MATTEO ZUCCHINI

Front page Inspired to ... Ratatouille a (2007) animated Disney/Pixar film

Anton Ego (in the picture) was the critic



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3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo
Lanthanides				58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
Actinides				90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

Other raw Critical materials

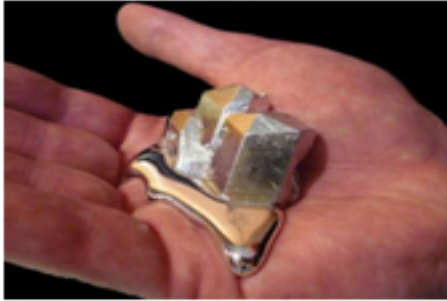
Coal coke	CaF_2	MgCO_3
Natural graphite	Phosphate rocks	Rare earth elements

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Candini Chiara, Poggioni Christian, Radi Silvia

Gallium

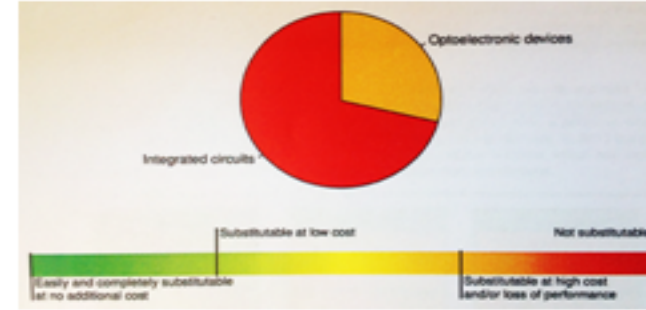
Gallium is a soft, silvery metal with symbol Ga and atomic number 31. It's a by-product of aluminium and in its pure, solid form, it is silvery white and has a fracture pattern similar to glass. Gallium comes from the lat name for France, Gallia. It also has origins in the Latin word gallos, a translation of leop, which means "rooster" and is also the first name of the scientist who discovered the element: Paul Emile leop de Boisbaudry. The latter observed two new violet lines in the atomic spectrum of some zinc. He knew it meant that an unknown element was present, but its existence, and properties, had been predicted by Mendeleev who had left a gap below aluminium in his periodic table.



USE

The commercial use of gallium is dominated by the semiconductor applications (98%).

- It is used to create very shiny mirrors
- Gallium arsenide is a useful silicon substitute for the electronics industry. It is an important component of many semiconductors.
- Thanks to its ability to convert electricity to light it is used in red LEDs (light emitting diodes). Solar panels on the Mars Exploration Rover contained gallium arsenide.
- It has important uses in Blu-ray technology, mobile phones and pressure sensors for touch switches.
- Gallium readily alloys with most metals. It is particularly used in low-melting alloys.
- It has a high boiling point, so it's used for recording very high temperatures that would vaporise a thermometer.



PROPERTIES

After a period in which the price of Gallium increased up to a peak of 666 US\$/kg in 2011, the price has declined. In 2015 the price of Gallium decreased continuously.¹

Gallium is a critical material because of the increase of the global demand and the concentration of the limited existing reserves in politically sensitive areas.

ORIGIN

The leading producer is China, which has increased its production capacity by a factor of five². Its competitors are Kazakhstan and Ukraine.

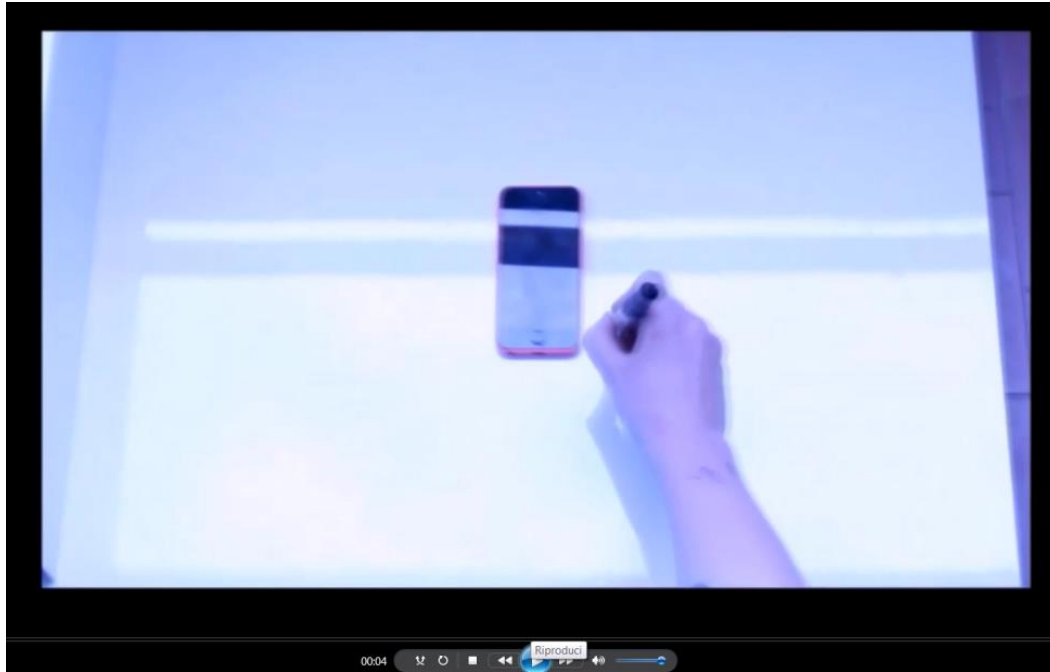
As it is primarily obtained from the circulation liquor in the Bayer process for aluminium oxide manufacture, gallium is a by-product of aluminium production and is not extracted in its own right.

SOLUTIONS

An alternative to GaAs is SiC because they have similar properties required for high-power and high-frequency electronics. While an alternative to GaN in LEDs and laser diodes is Zinc oxide (ZnO), an II-VI compound semiconductor.

However, currently substitution of Gallium in optoelectronic devices (LEDs, laser diodes, photodiodes and solar cells) is limitedly possible and only at loss of performance.

The LED industry waste dust contains primarily gallium as Ga. To develop treatment and recycling technology of these Ga bearing e-waste, leaching is the primary stage. Without pre-treatment, the gallium leaching was only 4.91 w/w % using 4M HCl, 100°C and pulp density of 20g/L. After NaOH chemical processing, both these processes achieved 73.65 w/w % of gallium leaching at their optimum condition.



See you-tube channel to see all the videos

A “crazy” example of
“re-use” of materials

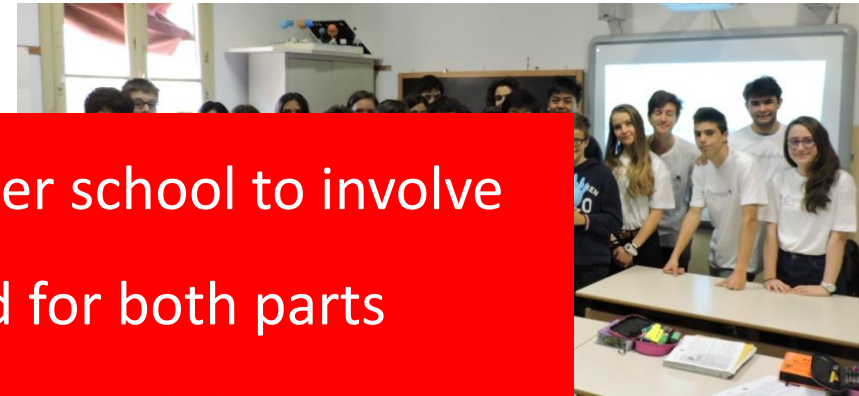


2) Peer-education:

Young RM Ambassadors ... in a school



THEORY



PRACTICE



- Additional step: another school to involve
- Very effective method for both parts
- Strong motivation/responsability
- More time required for “preparation”
- Multiple contact/experience with students



3) Public events (local/existing)

- **Contact(s)/network outside your own Institute(s)**
- **New experience/strong motivation and valorization**
- **Possibility to visit new places and move beyond standard schemes/places**
- **Strong preparation/organization (time)**
- **Strong support of teachers**



European Researchers' Night

2018



7 Cities



eit RawMaterials
RM@Schools

European Researchers' Night

RM@Schools in Hungary, September 28 2018

Bay Zoltán Campus, **Budapest**

200 participants






eit RawMaterials
RM@Schools

Public events

European Researchers' Night

RM@Schools in **Lisbon** (PT), September 28 2018

FCT NOVA University





eit RawMaterials
RM@Schools

Public events

European Researchers' Night

RM@Schools in **Stockholm**

September 28 2018

FORSKARFREDAG
— En del av europeiska Researchers' Night —

PARTNERS' NAME	ROYAL INSTITUTE OF TECHNOLOGY (KTH) AND GEOLOGICAL SURVEY OF SWEDEN (SGU)
ROLE:	PARTICIPANT
EVENT'S TITLE	FORSKARFREDAG (RESEARCHERS' FRIDAY)
DATE	SEPTEMBER, 28 TH 2018
WHERE	STOCKHOLM, VETENSKAPENS HUS (SCIENCES' HOUSE)
DURATION	9AM TO 3PM
NUMBER OF PARTICIPANTS	CA. 2000





eit RawMaterials
RM@Schools

Public events

European Researchers' Night

RM@Schools in **Tallin**

September 28 2018




European Researchers' Night

RM@Schools at *Liceo Copernico, Bologna (IT)*

in collaboration with *Liceo Galvani* and *Liceo Fermi*



September 28 2018



Among the numerous locations around the city, an additional site was hosted/organized inside the school LICEO N. COPERNICO



To share our experiences, learning pathways and teaching materials

<http://rmschools.isof.cnr.it>



HOME ABOUT US RESOURCES ▾ NETWORK GALLERY ▾ EVENTS ▾ CONNECTIONS **NEWS** CONTACTS

Seleziona lingua ▾ Powered by Google Traduttore

All carried out activities and events are shown on the Website, as well as the links to our social channels.



Webmaster:
Alessandra degli Esposti

To share our learning pathways and teaching materials

← ① rmschools.isof.cnr.it/moodle/



Virtual Centre



Welcome to our Virtual Centre, which proposes an active learning by involving 10-19 yrs students in experiments on raw materials. Learning pathways supplied with detailed explanations and toolkits to perform hands-on experiments are available here.

Course categories

- ▷ [Geology & Mining](#) ⁽⁴⁾
- ▷ [Recycling & Circular Economy](#)
- ▷ [Substitution](#) ⁽¹⁾

of.cnr.it



Documents with explanations
and tutorial video


RM@Schools

Separation of copper and iron – two approaches

Christian F. Otto, M. Sc.; Clausthal University of Technology, Institute of Organic Chemistry
 Dr.-Ing. Andreas Czymal, Windaus Labortechnik GmbH, Clausthal-Zellerfeld
 Jochen Brinkmann, M.A.; Clausthal University of Technology
 Dr.-Ing. Tobias Elwert, Clausthal University of Technology, Institute of Mineral and Waste Processing,
 Waste Disposal and Geomechanics

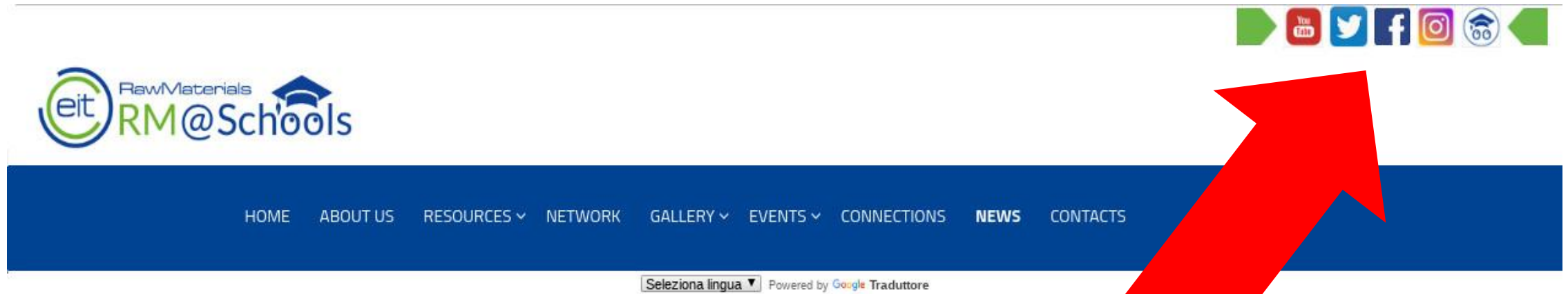


* E-Mail: brinkmann@tu-clausthal.de

**All produced materials are shared in the Virtual Centre,
from which you can download the experimental protocols
and get in touch with the experts.**

THE ACCESS IS FREE, BUT IT IS NECESSARY TO ENROLL !!

Sharing comments on the experiences and interconnection between EU schools are possible through our social networks: **Facebook, Instagram, Twitter, and our YouTube channel** (from the website)



RM@Schools on Social Media

Facebook page: Main promotional tool of RM@Schools

- All partners can directly post information, photos etc.
- All relevant activities reports should be posted here



Youtube channel: used to post/store all videos of events and projects

To submit a video for upload, send it to

socials-rmschools@isof.cnr.it



RM@Schools on Social Media

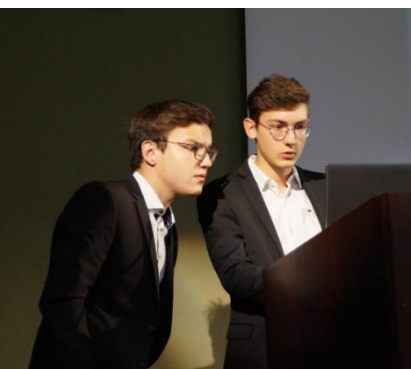
Twitter and Instagram: secondary promotional tools

- They will mirror Facebook and Youtube posts
- refer to **socials-rmschools@isof.cnr.it** to submit information



Everybody is highly encouraged to post all event and projects they take part to on their own accounts, and tag them with

#RMatSchools hashtag!



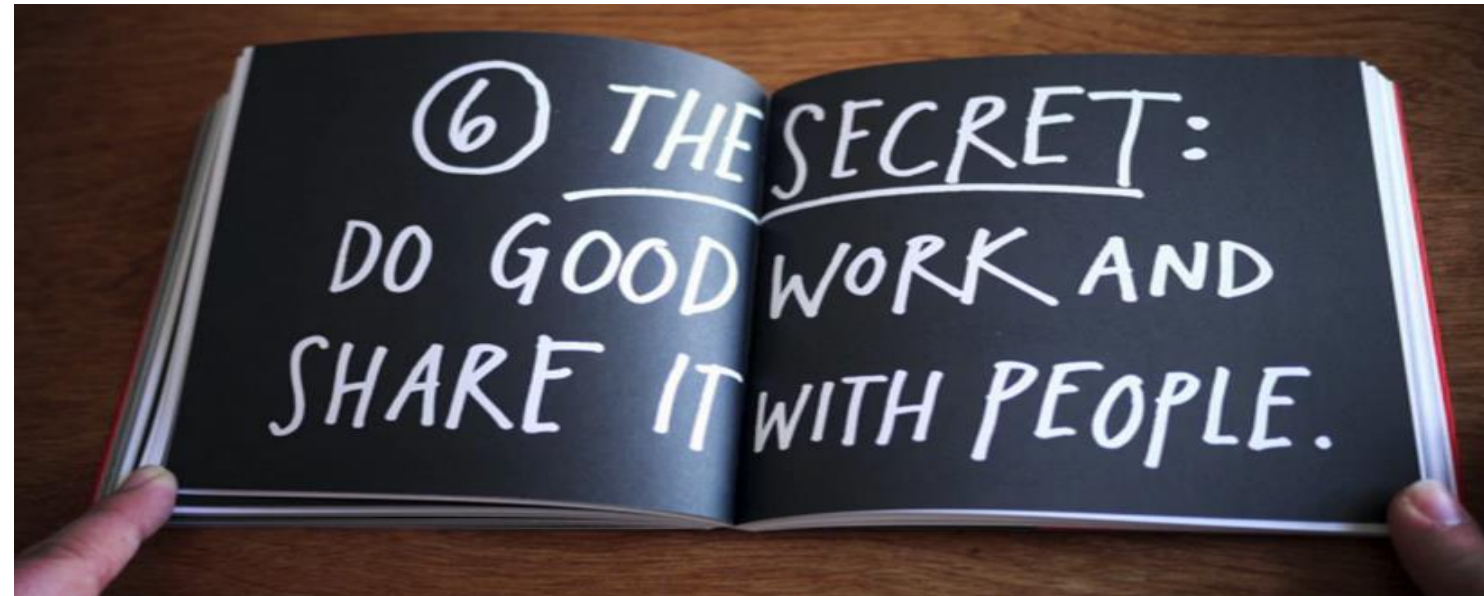
*Thank you for
your kind attention !!*

Mirko Seri



National Research Council of Italy

Email: mrko.seri@isof.cnr.it



Austin Kleon, author of the book "Steal like an Artist"