



**SCRREEN**

*Coordination and Support Action (CSA)*

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**Report on the delivery of case studies and webinars**

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### Summary

Report on the delivery of case studies and webinars

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### Approval

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## 1. INTRODUCTION

### Background

As signposted by the Raw Materials Initiative (RMI), primary and secondary resources as well as substitution options for raw materials are all strategies available to EU industry for mitigating risks associated with raw materials supply.

Substitution is the least advanced of these options. This is due to a number of reasons, one of which is the awareness of the different methods covered under the generic heading of substitution, and the potential for innovation that can result for considering this in the widest context.

## 1. PROJECT INSIGHTS

The work summarised within this report have been undertaken in pursuance of SCRREEN project Work Package 5. Task 5.4, in particular, has supported the development of deeper insights into the drivers, barriers and opportunities that arise during the development of specific substitutions, and the causes and results of these developments.

Discussions with companies that are operating in key sectors relevant to CRMs have taken place in task 5.4. Attention was placed on the use of components that are key to the major mega-sectors identified in deliverable 2.1 and have the maximum opportunity for substitutability as shown in deliverable 5.1.

Specifically, the trajectories of interest were those identified for the use of the following items:

- Alloys
- Magnets
- Batteries
- Electronic components
- and Catalysts (automotive and major other uses)

Task 5.4 continues to identify examples and case studies of how organisations impacted by the use of CRMs in these components have developed responses to minimise the threats to business continuity by developing substitution strategies.

## 2. METHODOLOGY & TIMELINES

For this deliverable, activity has been centred around a series of engagement activities and the development and delivery of two focussed webinars:

- 1- **Online survey** - sent out in January 2019 to +500 individuals, 24 responses received
- 2- **Short interactive survey** - held at the Materials Research Exchange Event in London 2018, completed by 20 individuals

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- 3- **One-to-one interviews** – Eight interviews have been undertaken with representatives from large multi-nationals, SMEs and expert consultants.
- 4- **Webinars** – two linked webinars were held as on-line events in May 2019.

### 3. EXTERNAL ENGAGEMENT ON SUBSTITUTION STRATEGIES, NEEDS AND OPPORTUNITIES

#### 3.1 ONLINE SURVEY

An online survey was sent out to 500+ individuals in January 2019. The invite and list of questions are as set out below. The responses to the survey were captured and summarised within the related 'Output Report' (see section 3.4).

The introductory text and the survey question set is included within Annex 1.

#### 3.2 SHORT, INTERACTIVE SURVEY

A Short interactive survey was undertaken at the Materials Research Exchange Event in London 2018, during a session delivered by David Gardner (KTN team member). The survey was completed by 20 individuals using the 'Mentimeter' online tool.

Reponses have been incorporated into the related 'Output Report' (see section 3.4).

#### 3.3 COMPANY INTERVIEWS

Eight interviews have been undertaken with representatives from large multi-nationals, SMEs and expert consultants. Organisations interviewed covered a broad range of industries and customer sectors, including:

- Automotive
- Marine
- Aerospace
- Magnet manufacture
- Rare earth alloys
- Electronics
- Batteries
- Chemical manufacturing.

Each interview included an introduction to the SCRREEN project and an overview of current issues around CRMs to set the context of the interviews and what would happen to responses. Discussions were then framed around a number of questions, including:

What CRMs are used by your organisation (or your clients) or what materials (if not listed) are considered to be critical?

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- Of these, which are the top three that are most important to your business operations?
- Have you got an example where you (or your client) have substituted a CRM for another material that we could use as a case study?
- Are you already aware of substitution opportunities for any of the materials identified?
- Using the value proposition canvas, can you identify potential options for substitution using any of the four methods?

Interview responses have been summarised (so there is no attribution) and incorporated into the related 'Output Report' (see section 3.4). Interview 'write-ups' are saved on file. The interview slide set is included within Annex 2.

### 3.4 OUTPUT REPORT

In Summary, the data from surveys and feedback from the interviews tell us that:

- The most common CRMs that organisations have experienced supply chain disruption in obtaining are: **Heavy and light rare earths; PGM / Platinum; Cobalt; Indium.**
- The most common type of supply chain risk that organisations experience is **sharp price rises**. Many companies are also concerned by **changes in export/import and EHS regulations**
- In order to mitigate supply chain risk, companies are working closely with suppliers and other partners to **add a second source of supply**. They are also active in **R&D associated with recovery and recycling**. Many companies, particularly those in emerging markets, are active in **R&D associated with substitution**.
- A significant number of organisations have dedicated resource to mitigate CRM risk. However, there is an equal number of organisations that do not have any dedicated resource to manage this risk – further awareness raising activities could be helpful to this community.

As noted above, the responses to the surveys and the company interviews have been summarised into a short, accessible report, entitled '*The Potential Impact of Critical Raw Materials on Business Continuity and Options to Minimise Risks: Latest Findings from Stakeholder Engagement Activities*'.

The reasoning behind publishing this report is twofold:

1. To ensure confidentiality of the responses, i.e. by grouping together.
2. To support future dissemination via an easy to read, summary document.

This report is intended to be a dynamic document, so that interview will be undertaken until SCREEEN project end and report content updated as appropriate and included in the 'Final Report'.

### 3.5 COMPANY CASE STUDIES

Three extended company case studies have been produced and can be found within Annex 3. These are:

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- 1- **“Lead-Free Electroceramics”, CERPOTECH.** Cerpotech (Ceramic Powder Technology AS, Norway) was established in 2007 as a Joint Venture between Norwegian University of Science and Technology (NTNU) and NTNU Technology Transfer AS.
- 2- **“Substituting Cobalt in Lithium-ion Batteries”. CERPOTECH.**
- 3- **Substitution of natural graphite battery anode materials using nano silicon’. NANOMAKERS.** Nanomakers (France) has been manufacturing silicon carbide and silicon nanopowder for 10 years.

There are a number of other case studies under development that were not ready at the time of finalising this report, but we anticipate will be published and disseminated before end of the year.

## 3.6 WEBINARS

### Aim of the webinars

The KTN organised a linked series of webinars to raise awareness of the issues and opportunities surrounding the substitution of critical raw materials.

The webinars were designed to generate an awareness of CRM supply chain risk and substitution strategies without going into too much detail on application of CRMs in all market sectors. Two webinars were held, each building on the other, with the final case study providing examples of ‘substitution in action’.

The theme for the first webinar was the historical activities and the view of drivers that exist today. The second webinar considered the economic and policy landscape today and consider how it might look in the future.

### Target Audiences

There were three main audiences for the webinars:

1. Those familiar with substitution of CRMs, either having implemented changes already, or have identified opportunities and have not yet implemented them, or rejected them.
2. Those familiar with CRMs, but have never considered substitution or are unaware of the different types of substitution options.
3. Those in an identified supply chain, but with limited or no interaction on the issues surrounding CRMs. This could be because their process or service itself does not rely on the use of CRMs, or that the suppliers to them or their customers have not raised the issue.

### Webinar Summaries

#### Webinar 1 – ‘Current situation of the use and substitutability of CRMs’

**Date** Wednesday, 8 May 2019 from 12:00 to 13:00 (UK time).

**Eventbrite link** [SCREEN Webinar - Current situation of the use and substitutability of CRMs registration](#)

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## Overview

This is the first in a series of two webinars designed to raise awareness of the issues and opportunities surrounding the substitution of CRMs. In this first webinar we will briefly cover the historical and current situation regarding CRMs. We will bring you up to speed on the substitution profiles of CRMs and also share the sustainability index for CRMs. We will also share feedback and insights gathered from a recent survey and interviews on what organisations see as the most critical CRM risks.

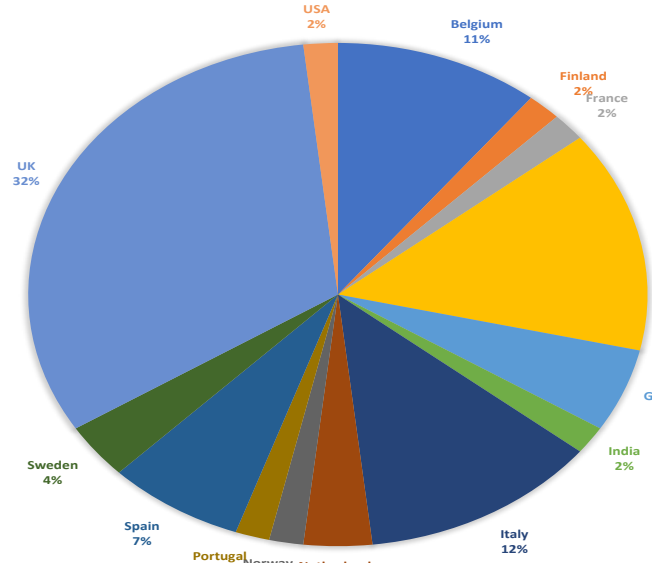
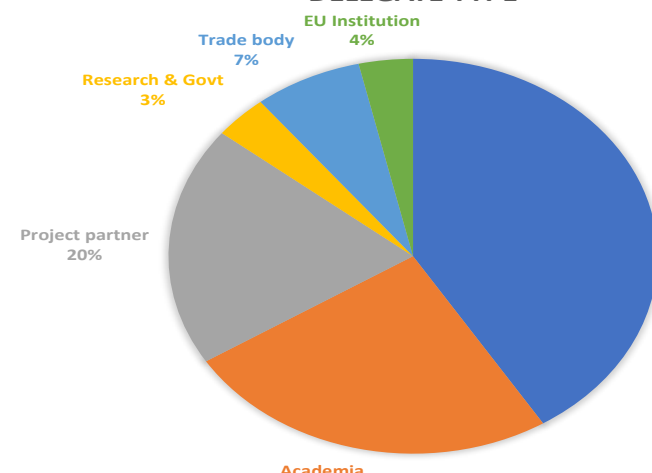
## Agenda

Time	Title of Presentation	Presenter
12:00 - 12:02	<i>Welcome &amp; Introduction to SCRREEN Project</i>	Peter Clark, KTN
12:02 - 12:20	<i>Latest CRM Substitution Profiles</i>	Luis Tercero Espinoza, Fraunhofer
12:20 - 12:35	<i>Introduction to the Sustainability Index</i>	Etienne Bouyer, CEA
12:35 - 12:50	<i>What do organisations see as the most critical CRM risks – sharing outcomes from recent Survey &amp; Interviews</i>	Peter Clark, KTN
12:50 - 13:00	Q&A from audience, then Close	Peter Clark, KTN

**Registrations** 95

**Dial-ins** 56 (59% attendance rate).



<p><b>Delegate summary</b></p>	<p style="text-align: center;"><b>DELEGATE GEOGRAPHY</b></p> 
	<p style="text-align: center;"><b>DELEGATE TYPE</b></p> 
<p><b>Recorded session</b></p>	<p style="text-align: center;"><a href="#">SCRREEN Webinar 1</a></p> <p style="text-align: center;"><a href="#">EU Project SCRREEN Publishes Recordings and Slides from Critical Raw Materials Webinar Series</a></p>
<p><b>Post-webinar metrics</b></p>	<p>63 plays of webinar recordings.</p>

**Webinar 2 – ‘Policy and economic outlook for CRMs and case studies of substitution in action’.**

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<b>Date</b>	Wednesday, 15 May 2019, 12:00 pm – 13:00 pm		
<b>Eventbrite link</b>	<a href="#">SCRREEN Webinar 2 - Policy &amp; economic outlook for CRMs and case studies of substitution</a>		
<b>Overview</b>	This was the second in a series of two webinars designed to inform on recommendations for policy intervention, give an overview of economic drivers for the substitution of critical raw materials, and two case studies on the opportunities and challenges within alloys and batteries.		
<b>Agenda</b>	<b>Time</b>	<b>Presentation</b>	<b>Presenter</b>
	12:00 - 12:02	<i>Welcome and short introduction</i>	Darren Hill, KTN
	12:02 - 12:20	<i>Recommendations for policy intervention</i>	Günter Tiess, Angelika Brechelmacher, Minpol
	12:20 - 12:35	<i>Overview of economic drivers for substitution of CRMs</i>	Marjaana Karhu, VTT Technical Research Centre of Finland
	12:35 - 12:45	<b>Substitution Case Study (Alloys) - Opportunities and challenges in moving to a service-for-product model</b>	Andrew Clifton, Rolls Royce
	12:45 - 12:55	<b>Substitution Case Study (Batteries)</b> <i>Future opportunities for substitution of Cobalt</i>	Guttorm Syvertsen-Wiig, Ceramic Powder Technology AS
	12:55 - 13:15	<i>Q&amp;A from audience</i>	Darren Hill, KTN
<b>Registrations</b>	86		
<b>Dial-ins</b>	44 (50% attendance rate).		

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<b>Recorded session</b>	<a href="#">SCRREEN Webinar 2 of 2</a> <a href="#">EU Project SCRREEN Publishes Recordings and Slides from Critical Raw Materials Webinar Series</a>
<b>Post-webinar metrics</b>	19 plays of webinar recording.

## CONCLUSIONS & RECOMMENDATIONS

The activities undertaken within the 5.4 task and summarised within this report, have produced a wide range of insights and opinions on CRM substitutability opportunities and issues. The project itself, its aims and the specific objectives of the Work Package 5 have been communicated to a diverse range of stakeholders.

It is recommended that a further round of company interviews is undertaken to build on the momentum of the webinars and the 'Output Report', the findings of which can be incorporated into an updated version of the latter document and can inform the SCRREEN Final Report.

## ANNEXES

### ANNEX 1. ONLINE SURVEY

#### On-line Survey

##### **Introduction**

*As a previous contact for the Framework 7 project CRM Innonet (or a contact that has expressed interest in this area) we would like to invite you to participate in this short on-line survey to identify the barriers and issues associated with the substitution of Critical Raw Materials. The survey should take no more than fifteen minutes. Please complete the survey with your initial thoughts, but if you would be willing to participate in a longer interview, then please tick the final box, and we will contact you afterwards. To organise a date and time for a more in depth interview. We would be grateful if you could complete the survey by Friday 11 th January.*

*The work is being conducted as part of the EU Horizon 2020 funded project SCRREEN (Solutions for Critical Raw Materials – A European Expert Network) You can access the survey by clicking the link below. You can also find out much more about the project by visiting the SCRREEN Project website (information and link below).*

*For this project, substitution covers the following four aspects:*

- *Substance for substance (one material is a direct replacement for another and delivering the same or similar functionality)*
- *Service for product (a product is replaced by a new service, which then eliminates the need for the critical material – e.g. on-line media instead of using DVD players)*
- *Process for process (a new process route is developed that no longer requires the use of a CRM)*
- *New technology for substance (updated capability the delivers enhanced functionality, but no longer requires the use of CRMs).*

*Survey link*

##### **Project Overview**

*SCRREEN is coordinated by the French Alternative Energies and Atomic Energy Commission (CEA). The consortium comprises 30 partners from 15 countries. SCRREEN aims to become the reference adviser in Europe for CRM strategy. It will become an umbrella network bringing a single voice to the highest level. With the project's multidisciplinary consortium, it embraces all the existing networks, associations and initiatives that are willing to play a role in the European CRM strategy.*

##### **Survey**

<b>Survey</b> About You (if not linked already via reply) Name Organisation
--

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Email

Organisation type

*SME*

*Large industry*

*Academia*

*Other*

**What materials do you use?**

1) What CRMs are used by your organisation or your clients (multiple options possible)

- antimony,
- baryte,
- beryllium,
- bismuth,
- borate,
- cobalt,
- coking coal,
- fluorspar,
- gallium,
- germanium,
- hafnium,
- helium,
- indium,
- magnesium,
- natural graphite,
- natural rubber,
- niobium,
- phosphate rock,
- phosphorus,
- scandium,
- silicon metal,
- tantalum,
- tungsten,
- vanadium,
- platinum group metals,
- heavy rare earths,
- light rare earths
- Others critical to you but not listed – option to write free text here

What other materials do you use that you consider critical to your organisation (i.e. are of large economic importance to you and you have identified some significant level of risk to the supply of that material), but are not listed – **option to write free text here**

2) Of these – which are the top three

List as above (but limited to 3)

**What issues have been related with the supply of these materials?**

Have you experienced issues with the supply of material that has impacted your business? – Multiple options possible

- No
- Up to one week delay
- Up to one month delay
- Over one month delay
- Sharp price rises
- Less delivered than expected
- Quality not accepted and returned
- Materials become subject to regulation
- Other
  - Give option to write text here

Choose one issue that has impacted your business the most (just one option)

- No
- Up to one week delay
- Up to one month delay
- Over one month delay
- Sharp price rises
- Less delivered than expected
- Quality not accepted and returned
- Materials become subject to regulation
- Other
  - Give option to write text here

Have you taken or would you consider taking any steps to minimise the impact of supply problems (multiple answers)

- No
- Changed source of supply
- Added a second source of supply
- Investigated recycling / recovery / reuse of material internally
- Investigated recycling / recovery / reuse of material within the supply chain
- Identified alternative materials within the product / process
- Changed product / process
- Acquire part of your supply chain to secure your material (i.e. vertical integration)
- Other
  - Give option to write free text here

Which single action would you consider most likely for you to take to mitigate a supply chain risk (single answer)

- No
- Changed source of supply
- Added a second source of supply
- Investigated recycling / recovery / reuse of material internally
- Investigated recycling / recovery / reuse of material within the supply chain
- Identified alternative materials within the product / process or considered substitution in the widest context

- Changed product / process
- Acquire part of your supply chain to secure your material
- Other
  - Give option to write free text here

How would you compare the risks associated with CRM supply in comparison to your other business continuity risks? (single answer)

- It is a business-critical issue with dedicated resource to manage it
- It is considered a risk and managed as part of our other continuity risks
- It is not considered a significant risk to our business and therefore we do not dedicate resources to manage it
- We have not looked at it

**Opportunity to provide information on case studies and Separate Interview**

Do you have any examples of where you have substituted one material for another, or are you aware of any examples in your sector (this is substitution in the widest context as given in the introduction)? Yes / No

If so, would you be willing to provide more information? Yes / No

Have you been involved in any funded projects on critical raw materials?

(If box ticked – then come up with additional questions which will be:

Project name for European projects, and for National Projects and Other – funding body and project name)

European

FP7

H2020

Other

National

Funding body?

Other

Free text here

Yes, I would be willing to participate in a longer interview Yes / No

## ANNEX 2 – COMPANY INTERVIEW SLIDES

A PDF version of the presentation during the company interview process is uploaded to the SCRREEN partner portal.

## ANNEX 3 – CASE STUDIES

### CASE STUDY 1 – CERPOTECH, “LEAD-FREE ELECTROCERAMICS”



#### About Cerpotech

Cerpotech (Ceramic Powder Technology AS) was established in 2007 as a Joint Venture between Norwegian University of Science and Technology (NTNU) and NTNU Technology Transfer AS. Since 2013, Cerpotech has been located at semi-industrial production facilities in Trondheim.

Cerpotech’s core competencies and interests lie in the development and application of spray pyrolysis technology preparing complex oxide powders from aqueous precursor solutions. This scalable process is very versatile, capable of preparing a wide range of oxides. Cerpotech’s main commercial focus is development of high-quality powders for applications including energy storage (Solid Oxide Fuel Cells, Batteries), gas-separation membranes, catalyst and lead-free electroceramics & piezoceramics.

#### The Need

Electroceramic materials play an important role in many everyday products:

- Automotive: Parking sensors, fuel injectors, knocking sensors, pressure monitors, keyless doors, sensors
- Medical: Ultrasound, heart monitors, implants
- Consumer: Printers, disk drives, speakers, microphones cigarette lighters, lenses
- Defense/Industrial/Subsea: Sonar, geological mapping, guidance systems, crack detection, microscopes

However, EU legislation is restricting the use of hazardous substances in electrical and electronic equipment.

One of the most popular piezoelectric materials is **PZT**, or lead zirconate titanate ( $\text{Pb}(\text{Zr,Ti})\text{O}_3$ ). Around 1000 tonnes of PZT is produced in Europe each year. Some applications are currently exempt under RoHS however the exemptions are expected to expire, or renewed, in 2021-2024.

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The race is on to commercialise new lead-free materials. These materials are likely to be prepared with other methods and have different microstructures compared to existing materials which means industry will need to invest in new production lines and process technology which is likely to take a number of years. There are also a number of regulatory hurdles as well as challenges around standardisation and safety testing that will all require investments.

### The Results

Cerpotech has developed protocols to prepare materials within the KNN-, BNT-, and BCTZ-systems and has or is participating in several projects to demonstrate the processing of these powders into devices.

- FORNY (Norwegian Research Council): Tape casting and sintering of KNN thick films.
- COLDPIE (Innovation Norway): Demonstration of the feasibility of mass production of competitive lead-free multilayer chip piezo actuators.
- 3D-PIEZO (MANU-NET, Reference No MNET18/ADDI-3405): Aims to establish a manufacturing chain for 3D printing and multilayer lamination of lead-free piezoelectric elements for ultrasonics and other applications.

### Competitive Advantages

- Early movers. Very few companies offer the lead-free electroceramic materials expected to replace PZT commercially.
- Small particles. Potential for preparing thinner films than for coarser powders.
- Sinterability. Materials made by soft chemistry routes such as spray pyrolysis require lower processing temperatures compared to conventional synthesised materials.
- Controlled stoichiometry. Lower temperature
- Cheaper electrode materials. The lead-free piezoelectric materials can be processed under reducing atmosphere which means that expensive silver-platinum electrodes may be replaced with transition metals such as nickel or copper.

### Quote from company

*Asia is leading the world in commercialising lead-free piezoelectrics. Research projects like this are important but further funding and investment will be needed to ensure that European industry remains competitive.*



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**Fig: KNN powder prepared by Cerpotech.**

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## CASE STUDY 2 – CERPOTECH, “SUBSTITUTING COBALT IN LITHIUM-ION BATTERIES”



#### About Cerpotech

Cerpotech (Ceramic Powder Technology AS) was established in 2007 as a Joint Venture between Norwegian University of Science and Technology (NTNU) and NTNU Technology Transfer AS. Since 2013, Cerpotech has been located at semi-industrial production facilities in Trondheim.

Cerpotech’s core competencies and interests lie in the development and application of spray pyrolysis technology preparing complex oxide powders from aqueous precursor solutions. This scalable process is very versatile, capable of preparing a wide range of oxides. Cerpotech’s main commercial focus is development of high-quality powders for applications including energy storage (Solid Oxide Fuel Cells, Batteries), gas-separation membranes, catalyst and lead-free electroceramics & piezoceramics.

#### The Need

The rechargeable battery market grows at speed, at the same time the price per kWh is decreasing. The initial driving force is Electric Vehicles.

Li-ion batteries are expected to be the preferred technology in the near to mid-term with the cathode materials being based on NMC (Nickel-Manganese-Cobalt).

However, cobalt is classified by the EU as a Critical Raw Material. It is toxic, expensive and there are concerns regarding the ethics associated with extraction practices in areas like the Congo.

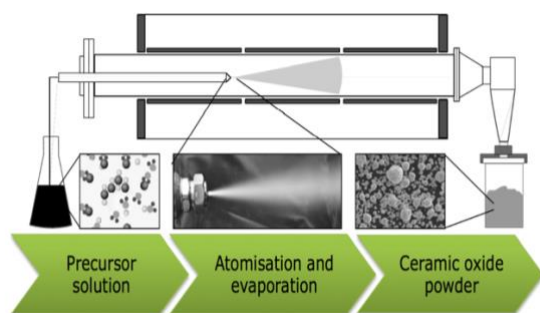
The challenge is to obtain better performance and cheaper batteries without using cobalt.

#### Competitive Advantages

- Cerpotech’s production process provides an opportunity to develop new battery cathode materials with optimised morphologies.

#### Pictures

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**Fig: Cerpotech's spray pyrolysis technology**

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## CASE STUDY 3 – NANOMAKERS. “SUBSTITUTION OF NATURAL GRAPHITE BATTERY ANODE MATERIALS USING NANO SILICON”



#### About Nanomakers

Nanomakers has been manufacturing silicon carbide and silicon nanopowder for 10 years. Historical links with CEA has meant the company has been able to capitalise on 20 years of research on nanopowders and their production, the company is now the sole licensee of CEA patents in the area leading to the development of industrial production processes.

The first production line was established at Rambouillet, in North-Central France, in 2012.

Nanomakers utilises laser pyrolysis in the production process and has placed the highest levels of control and procedure around production of nanopowders to maintain a safe and controlled environment.

#### The Need

Natural graphite is identified as a critical raw material (CRM) on the European Commission CRM list. Natural graphite is currently used in as an anode material in lithium ion batteries with the increase in electrification of vehicles there may be future concerns around the supply of natural graphite for these applications. Silicon has been identified as a good candidate to substitute for natural graphite.

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One of the key drivers for this project is the development of materials that provide an increased performance when compared to natural graphite materials. The use of silicon as an anode material offers the opportunity to increase the performance of a battery system. Increasing battery performance is a key driver for the project as generally the availability of artificial graphite globally is not a concern.

### **The Results**

Project Sirius (supported by EIT and including CEA, SGL Carbon GmbH, VARTA and Nanomakers as partners) aims to replace natural graphite in the anode of lithium ion batteries with silicon providing increased performance, with a target of batteries lasting 30 – 40 % longer. Key activities within the project have been;

- Scale-up of materials into production
- Development of new materials for high performance applications

The scale-up of materials to production scale has been completed successfully within the project. The product meets the customer performance targets and cost demand.

Customer specification related to performance of new materials has provided the consortium with targets for new material production. Several new materials have been prepared to meet the ambitious performance targets further development of materials is ongoing.

### **Competitive Advantages**

The project has provided Nanomakers with the opportunity to scale-up production and continue with R&D development of the next generation materials. This continues to expand the offering available and has improved company knowledge around the materials performance within lithium ion batteries.

There are other state of the art materials i.e. silicon oxide, which can substitute graphite however the increase in performance capacity may be limited, this is not the case for silicon the materials developed by Nanomakers.

The materials will initially be used in high end battery applications for example smart phones before moving into electric vehicles where silicon anodes may have a significant share of the market by 2030.

Project link: <https://eitrawmaterials.eu/project/sirius/>