PARTNER PROFILE / PROJECT IDEA

Topic

SPIRE-07-2015: Recovery technologies for metals and other minerals

Title

TBD – contact person callegati.e@crit-research.it

Company Presentation

Becromal was founded in 1955 and is producing **aluminum foils for electrolytic capacit**ors. At Becromal, the raw foil undergoes a multiphase electrochemical process that modifies the surface structure of the foil at a microscopic level, in order to increase its electrical capacity (i.e. etching) and create a stable oxide layer on its surface (i.e. forming). The foil is the main raw material used for the construction of aluminum electrolytic capacitors ensuring the functionality of almost all electronic circuits and electrical appliances, including applications for the renewable energies (wind, solar) and all kind of power supplies.

Becromal, worldwide one of the largest manufacturers of aluminum foils for electrolytic capacitors, is **headquartered close to Milan, Italy** and it owns a forming plant in Iceland. To meet top quality requirements, Becromal has been CECC certified and obtained the ISO 9001:2000 certification in 2004 (Italy), and applies many of the most important requirements of the ISO TS 16949:2002 which are regularly used in the APQP procedures as well as the FMEA, MSA, and SPC tools for automotive sector. The company, with a turnover in the range of 100 million euros per year, is since 1992 owned by EPCOS, a manufacturer electronic components part of the Japanese TDK group.

Objective

The objective BECROMAL within the call "SPIRE-07-2015: Recovery technologies for metals and other minerals" is **to develop and demonstrate the application of innovative processes for aluminum salt solutions**, recycling and valorizing waste streams coming from aluminum etching process as by product. The new selected technology will be based on an innovative approach that consists of 3 main pillars:

1. Obtainment of **amorphous bohemite** through neutralization-cleaning-drying of exhausted pre-etchnig waste streams, to be used as **raw material in the cement industry**
2. Obtainment of **aluminum oxide (alumina)** through spray-roasting of exhausted etchnig waste streams, to be used as **raw material in technical ceramics and polishing products**
3. Obtainment of **aluminum oxide in nano-particles** through flame-spray pyrolisis- of etched foil quality controls scarp materials, to be used as **raw material for nanotechnology applications**

The technology will be demonstrated in a real industrial setting for the production of etched aluminum foils, and will enable to reduce the process environmental impact, through an increase of the process resource efficiency, through the production of by-products with a high added value, instead of waste materials that need to be disposed, and through an increase of the operations performed in-situ (optimizing logistics and CO2-related emissions).

The main research objectives will be:

- To design and test a **neutralization-cleaning-drying based process** to convert aluminum salt into aluminum hydroxide, optimizing product yield, morphology and purity;
- To design and test a **spray-roasting based process** to convert aluminum salt into aluminum oxide, optimizing product yield, morphology and purity, and recycling up to 95% of fresh acid used as a raw material in the aluminum etching process;
- To design and test a **flame-spray pyrolysis based process** to convert aluminum salt into aluminum oxide with nanometric sized, controlled morphology and high purity (≥99,99%) including industrial manufacturing scale up;
- To **merge the new technology with the current aluminum etching process** to obtain a single integrated process maximizing productivity and resource efficiency
- To demonstrate the advantages of the new technology in **a real industrial setting**, in the premises of BECROMAL (Milano, Italy).

Background

Aluminum foils etching is a complex process used for the production of electrolytic capacitors, **a key component of all electronic circuits and electrical appliances**, including applications for the renewable energies (wind, solar) and all kind of power supplies. In the conventional etching process, the raw foil undergoes a multiphase electrochemical process that modifies the surface structure of the foil at a microscopic level, in order to increase its specific surface electrical capacity (i.e. etching) and create a stable oxide layer on its surface (i.e. forming).

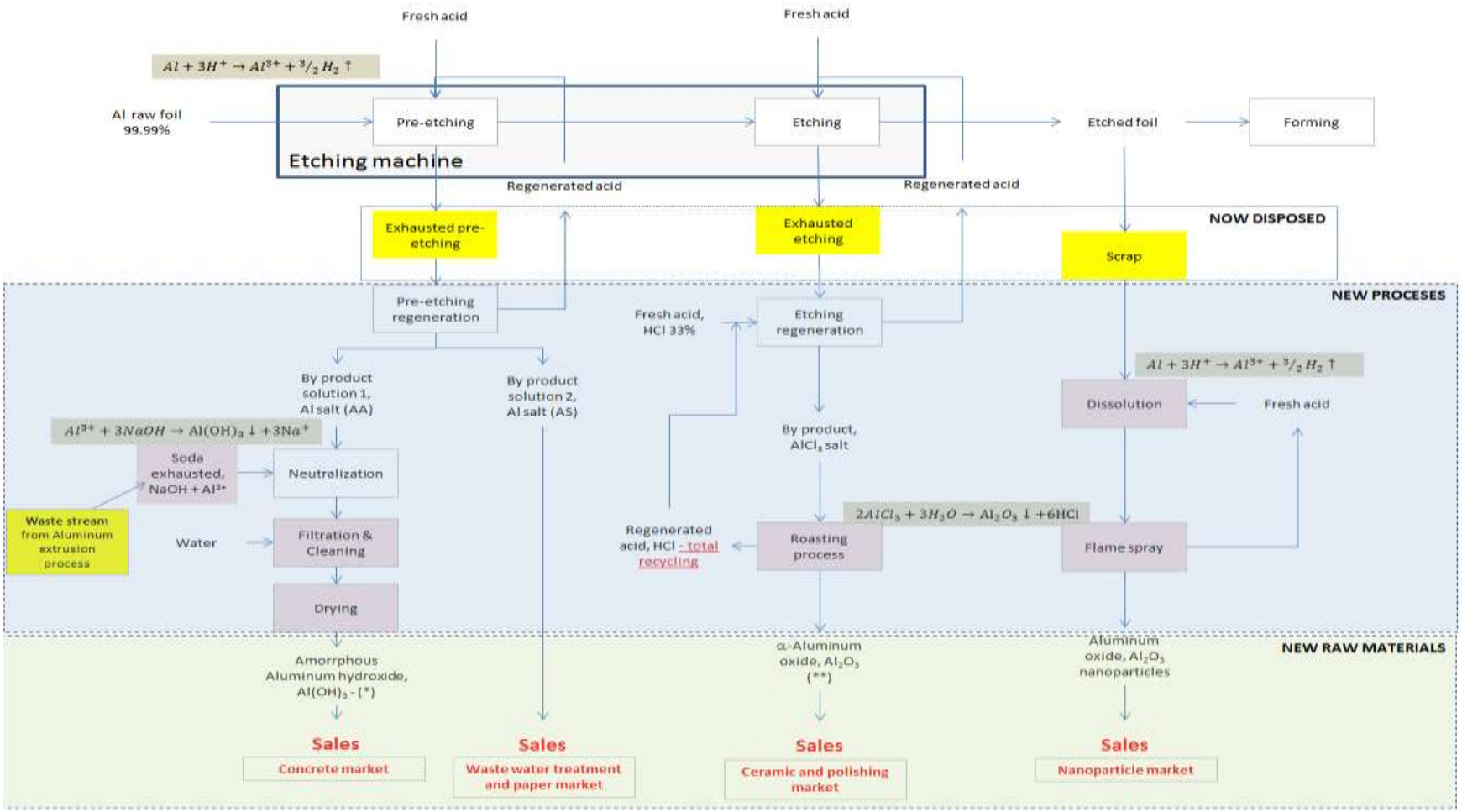
Such process, despite being vital to the production of a wide range of everyday life objects, poses **several problems related to environmental impact**, sustainability and dependency from imports. In particular, polluting chemical waste streams (notably aluminum salts - AlCl3) arise from different process phases, including pre-etching and etching. In addition, being a top-down process, where material is removed to obtain the desired surface, etching produces a high amount of scrap material (around 30% of the aluminum undergoing the process in the form of Concentrated acidic aluminum salt solutions), and consumes a high amount of fresh acid (HCl).

Moreover, the further treatment of waste streams from the process, in particular AlCl3, now widely disposed through in water depuration, could allow to obtain, as a by-product, Alumina (Aluminum Oxide, Al2O3), a material now mainly obtained through the less environmental friendly processes. The development of **new processes to treat waste streams from the different aluminum etching phases** could thus highly improve the process sustainability and environmental friendliness.

Results

The ASSET project will result in an innovative, resource efficient, energy saving and environmental friendly technology for the treatment of waste streams coming from industrial aluminum foils electrochemical etching. The treatment process will be based on neutralization, spray-roasting and flame-spray pyrolysis.

The new process will modify the existing one as follows:



(*) Amorphous Aluminum Hydroxide, white powder, concentration ≈ 80%, wet ≈ 20%, particle size ≈ 10 mm, impurity < 2%.

(**) Aluminum Oxide,, white powder, α crystalization, purity ≈ > 99.5 %, particle size ≈ 10 µm,

Expected impacts are the following:

- **reducing dependency from imports**, by producing High Purity Micro-Sized Alumina which now is mainly imported from non-eu countries (US, China, Japan);

- increased **resource efficiency of the aluminums etching process**, by recovering aluminum salt and regenerating and reusing up to 95% of the hydrochloric acid;
- higher **sustainability of a new alumina production process** which will eventually be proposed as an alternative to conventional processes that in some cases have shown disastrous environmental impacts
- improving **downstream user processes** such as polishing
- reduction of **greenhouse gas emissions** by significantly reducing the need for transport of waste streams and raw materials
- technology transfer to neighboring industries (other non ferrous metals magnesium, nickel, chrome)

The process will enable to **tailor Alumina properties (morphology, purity, particle size) according to different final applications**, and will lead to a lower dependency of Europe from alumina imports which is critical in several sectors including ceramics, cement and chemicals.

End users are divided into two categories:

- High quality Alumina powder is currently used as a **raw material in several industries** including high-tech ceramics and precision polishing products, and as catalyst in process industries, and energy storage application.
- Similar industries to Becromal (other non ferrous metals magnesium, nickel, chrome) which can use the project results for technology transfer

Keywords Aluminum foils, etching, spray roasting, flame spray pyrolysis, alumina, technical ceramics

Involved entities:

- BECROMAL (Italy, Large enterprise) → Plant owner
- CNR-ISTEC (Italy, RTD) → Process characterisation
- SCHOLL Concepts (Germany, SME) → End user (alumina for polishing products)
- ANTRITZ (Engineering company AT) → Plant design and installation
- CRIT Research (Italy, SME) → Dissemination