PLASMA-INDUCED SELECTIVE EXTRACTION AND RECOVERY OF METALS FROM ELECTRONIC WASTE

This invention enables the multi-selective and continuous extraction of metals from discarded phones, computers, capacitors, LED...., and from natural ore, glass, mirror... It thus provides an innovative solution for recycling the growing amount of electronic waste and for extracting strategic high value metals.

Context

There is a rapid increase in the amount of electronic waste, caused by an enhanced production and consumption of electronic devices such as laptops, phones, LED, etc. The recycling of materials such as metals, mineral products, polymers resins, present in electronic devices is particularly difficult when there are complex alloys formed by many elements (Fe, Co, Cu…).

Techniques such as hydrometallurgy and pyrometallurgy have been used to extract species from a matrix, however they present many drawbacks. Hydrometallurgy is not adapted for recycling electronic waste characterized by a matrix made with variable alloys. Although pyrometallurgy could be adapted to recycle electronic waste, it is energy consuming, and the purification of the extracted metal may not be constant and of high quality.

There is thus a need for new technologies that can facilitate the recovery of metals from electronic waste.

Invention description

The invention provides a process and a system which allow the continuous and selective extraction of metals from matrices of diverse compositions.

A plasma is injected in an extraction chamber with a plasma torch and the matrix is placed into the chamber on a movable support, at a determined potential. Molecules are formed at the surface of the matrix, where they evaporate, some are destroyed. Chemical elements from these molecules and those extracted from the matrix are excited. There is a continuous monitoring of the chemical elements present in the plasma by optical emission spectroscopy.

Selective extraction of species is made possible by a control unit which adjusts the distance between the support and the plasma torch and sets the composition of the injected plasma by selectively mixing a plasma-producing gas (*e.g.* argon, helium) and an additive gas (*e.g.* oxygen, hydrogen) in regards to the monitored excited elements. In the extraction chamber, a plate situated outside the plasma allows the reformation of destroyed molecules and the collection of the molecules of interest by deposition onto the plate.

Added value

The technology allows a **low-cost extraction** of **any metallic species** - including rare earths - (*e.g.* Fe, Cu, Sn, Al, Si, Au, Ag, In, Li, Nd, La) from matrices composed of electronic waste or

natural ore, of any composition. The **system** (extraction chamber, matrix on a support, plasma torch, optical emission spectroscopy apparatus) is **highly reactive**; it can be adjusted in real time and be adapted to the species to be extracted.

The **extraction process is selective**, which means that a **high degree of purity** can be reached. In addition, **several species can be extracted consecutively** from the same matrix during the same process.

Potential market

This invention presents high potential for the recycling of electronic waste and the extraction of metals of strategic importance. It can be used also for the recycling of capacitors and LEDs.

This technology is validated; it has been successfully used to extract (i) tin from a matrix formed by 85% of copper and 15% of tin and (i) copper from a matrix composed by 75% of iron and 25% of copper.

Intellectual property

WO2017211994 (pending)

Keywords

Species specific extraction; Plasma torch; Matrix; Extraction chamber; Optical emission spectroscopy; Pure metals; Strategic metals; Electronic waste recycling; Capacitors and LEDs recycling

Technology domain

Materials; Metallurgy; Metal extraction; recycling

Technology transfer contact

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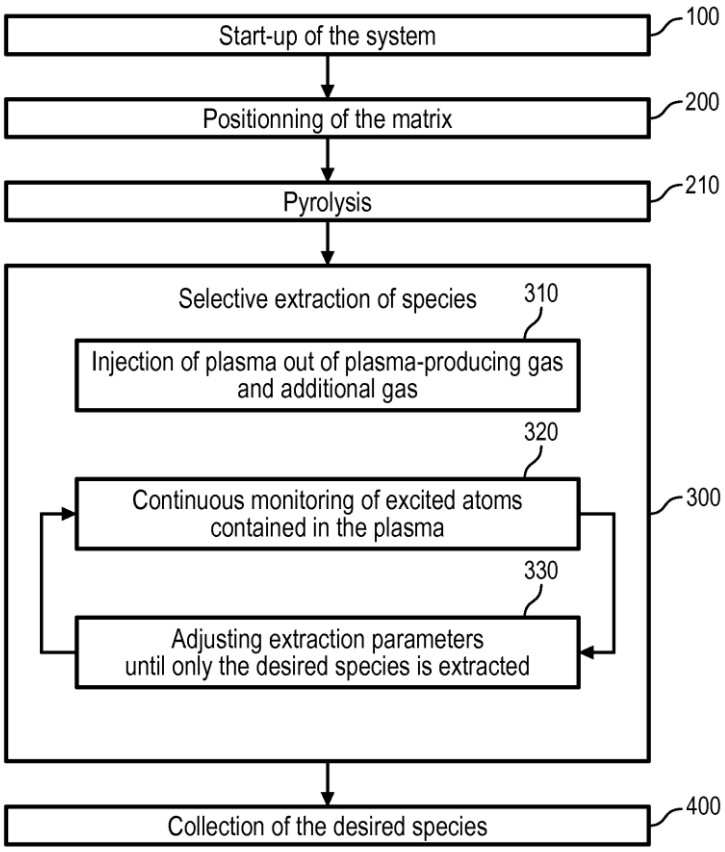

Fig. 1. Main steps of the extraction process

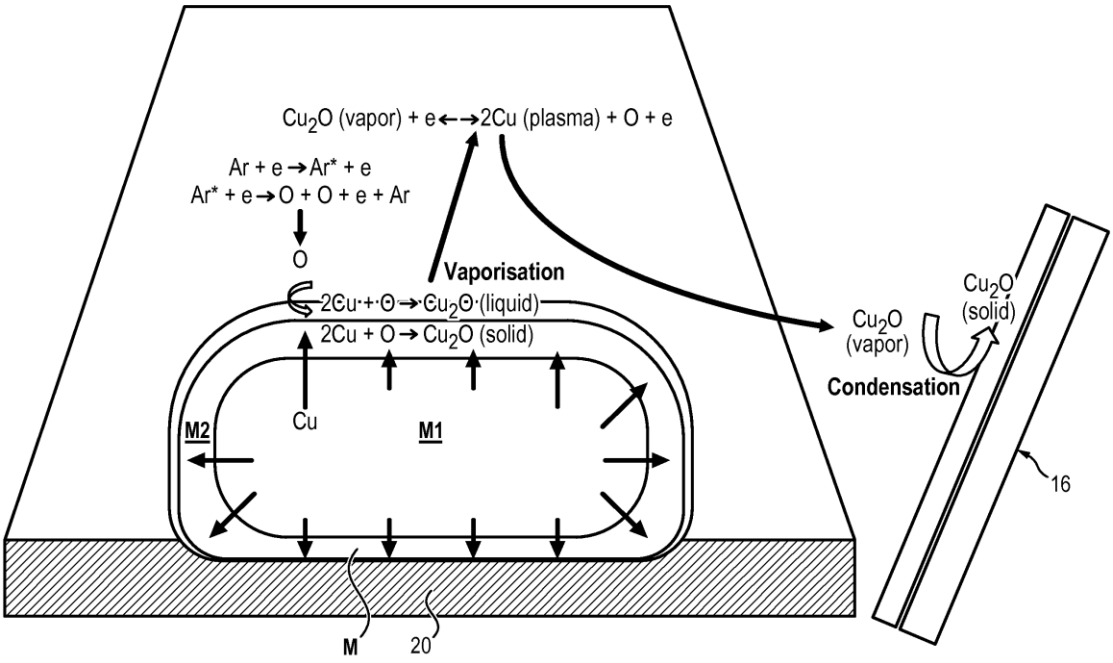

Fig. 2. Chemical phenomena of the extraction process