The invention relates to a novel process and method of recovery of non-metallic contents (especially epoxy fiber glass) from the waste printed circuit boards for its reapplication in the form of fillers for other products, such as construction materials, decorating agent, adhesives and insulating materials etc. Populated PCB is taken for recovery process and undergone through a disruptive technological route for component removal process. Furthermore, the proposed invention provides recovery of metal values present in the shredded or blank printed circuit boards in pure form. The metals recovered from the blank printed circuit boards possess purity of about 99%.
PROCESS FOR RECYCLING EPOXY RESINS FROM ELECTRONIC WASTE AND PRODUCT THEREOF

FIELD OF THE INVENTION

The present invention relates to a process for recovering of non-metallic materials of electronic wastes like printed circuit boards. More particularly, it relates to method to enhance re-usability of epoxy fiber glass recovered from electronic waste printed circuit boards in the form of fillers for utility application products, such as construction materials, decorating agent, adhesives and insulating materials etc.

BACKGROUND OF THE INVENTION

Printed circuit boards (PCB's) are the main components of electrical equipments without which such equipments cannot work properly. Recycling of PCB's is an important task not only due to safe waste management but also because of their precious composition. PCB is particularly problematic to recycle because of its heterogeneous mix of organic materials, metals and glass fibers. Printed circuit boards contain metallic and nonmetallic contents. When these boards became waste products, the precious metals are then recovered in order to use them again. The number of approaches have been introduced to recover precious metallic contents or for effective waste management process.

Waste management scientists are mainly applying their intellect towards finding ways to recover precious metals from electronic wastes. Whereas, the non-metallic content has acquired low interest in the recovery process. In most of the cases, the non metallic contents are either discarded or incinerated after a metal recovery process, considering them as a waste product.
Indeed, the nonmetallic contents have specific physical characteristics that can make them equally valuable during a recovery process. The nonmetallic materials can be used in several ways based on the physical characteristics of the nonmetallic contents. For example, the nonmetallic contents of PCB's are considered as much lighter than cement and sand, has finer granularity that makes the microstructure more reliable, and contains coarse glass fibers which could improve mechanical strength of the materials.

The most attractive aspect of reusing non-metallic content of waste PCB's is the potential economic benefit because their recovery not only recycles waste PCBs but also earns a profit.

WO1996016112A1 discloses a process for recycling epoxy resin containing products and substances, such as for example printed-circuit boards, and for reusing the decomposition products. The epoxy resin containing materials to be recycled are intensively mixed for between 2 and 10 hours with one or a plurality of polar solvents, which modify the physical-chemical structure of the epoxy resin matrix, at a processing temperature of between 140 and 280 °C, and are acted upon by mechanical forces and optionally pressure. The non-dissolved solid fractions (glass fibers, metal parts) are then separated from the resultant decomposition product and, after appropriate intermediate treatment, are subject to an individual reuse process, whilst the resin polymer is dissolved out of the dissolved liquid decomposition products or the polymer decomposition product, after the addition of suitable reagents, is used directly for producing a new resin product.

The main limitation of the process described therein, is the complexity, and use of organic solvents that leads to increase processing costs. Further, the disclosed process does not provide any approach for recovering metallic contents present in the printed circuit boards.
Hence, a successful recycling approach of waste PCB's should be taken into consideration to separate non-metallic materials for the purpose of their reapplication. Recycling of PCB in particular, is still a challenging task due to complexity of these materials and possible emission of toxic substances. Also, in case of land fill, epoxy resins leach through rain water and contaminate ground water.

OBJECT OF THE INVENTION

The main object of the present invention is to provide an economically effective and eco-friendly process and method of recovery of non-metal contents (especially epoxy fiber glass) from the waste printed circuit boards for its re-utilization in the form of fillers for other products, such as construction materials, decorating items, adhesives and insulating materials etc.

Yet another object of the present invention is to provide a chemical free recovery process that works on density separation based principle.

Yet another object of the present invention is to provide a less toxic recovery process for non metallic contents of the waste printed circuit boards.

Yet another object of the present invention is to provide an eco-friendly, economic and effective recovery process with almost zero environmental pollution that runs at cheaper processing cost and generates high yield of recovered non-metallic contents.

Yet another object of the present invention is to provide a recovery process that yields ready-to-use end product which can be used as raw material for re-application purpose.

Yet another object of the present invention is to provide a raw material from waste printed circuit boards intended to be used as fillers for other products, such as construction materials, decorating items, adhesives and insulating materials etc.
SUMMARY OF THE INVENTION

The present invention relates to a novel process and method of recovery of non-metallic contents (especially epoxy fiber glass) from the waste printed circuit boards for its reapplication in the form of fillers for other products, such as construction materials, decorating agent, adhesives and insulating materials etc. Populated PCB is taken for recovery process and undergone through a disruptive technological route for component removal process.

Furthermore, the proposed invention provides recovery of metal values present in the shredded or blank printed circuit boards in pure form. The metals recovered from the blank printed circuit boards possess purity of about 99%.

DETAILED DESCRIPTION OF THE INVENTION

Component removal process in e-waste recycling is carried using a Component Removal Machine (CRM) that segregates all the components from the boards. Once, segregation process is accomplished, a blank board containing non-metallic content is obtained. The ratio of Blank board may vary depending on the types of populated PCBs used. The quantity of the blank board obtained is about 30-65% of the total amount of populated PCB's used.

Blank PCB boards are made up of epoxy fiber glass plastic with metal linings. They are subjected to shredding section wherein blank boards of initial size 150 - 400 mm are shredded to get 2-5 mm sized particles which are then subjected to pulverizing section.

In Pulverizing section, sized fraction from shredding section is fed with water to make slurry of epoxy fiber glass plastic and metals. The epoxy fiber glass with metal rich slurry
is then subjected to shaking table for separation of metals and epoxy fiber glass plastic slurry. The metals and Epoxy fiber glass particles having size 2 - 5mm present in the slurry differ in their specific gravity and hence the separation process follows gravity separation principle. Wet form of Epoxy glass fibers are then collected as tailings while metal part is collected as concentrate.

Metal part is dried and taken to smelting section for ingot production and further to electro refining section for purification resulting into 99% purity.

Epoxy Fiber glass plastic wet powder slurry is transferred to a settling tank wherein water trickles down through fiber bed which in turn results in the formation of epoxy fiber rich cake. The cake is then dried under sunlight and to evaporate water content. A solid powder form is then obtained which can be used as a ready-to-use raw material by industries for the purpose of electrical insulation, production of composite boards, production of flame proof products like doors, windows; the powder form may also be used as fillers to form composite panels, buildings, and in places wherein insulation flame proof approach is needed; the powder may also be used as decorating agent and in production of adhesives.

The present invention provides a process so as to obviate the burning of epoxy fiber glass plastic and is thus non-hazardous for health and environmental point of view.

In another embodiment, the invention provides an approach to recover metals that exist in the blank circuit boards (after shredding) in the form of metal linings in highly purified form. The recovered metals possess purity of about 99% with least amount of impurities (below 1%).
CLAIMS

We claim:

1. A process for recycling epoxy resins from electronic waste comprising the steps of:
   a) shredding blank printed circuit boards into particles of a preferable size;
   b) pulverizing the particles obtained in step a) with water to obtain a slurry of epoxy fiber glass resins and metal particles;
   c) shaking the slurry obtained in step b) on a shaking table to separate the epoxy resins and metal particles from the slurry;
   d) collecting the epoxy fiber glass resins as tailing from slurry and metals as concentrate;
   e) drying the metals concentrate obtained in step d), followed by smelting at a preferred temperature range to obtain a metal ingot;
   f) purifying the metal ingot of step e) through electro-refining step to obtain pure metals;
   g) transferring the tailing of step d) to a separation tank to obtain epoxy resins rich cake;
   h) drying the epoxy resins rich cake of step f) under sunlight to obtain epoxy resin powder.

2. The process for recycling epoxy resins as claimed in claim 1, wherein the preferable size of particles obtained through shredding is in the range of 2-5 mm.

3. The process for recycling epoxy resins as claimed in claim 1, wherein the preferable range of temperature during smelting is 1200 - 1250 °C.

4. The process for recycling epoxy resins as claimed in claim 1, wherein the recovered metal is copper.
5. The process for recycling epoxy resins as claimed in claim 4, wherein the copper metal has purity of 99%.

6. The process for recovering metals of value as claimed in claim 1, wherein the copper obtained in step f) has metal impurity level below 1%.

7. The process for recovering metals of value as claimed in claim 1, wherein the epoxy resin powder obtained in step h) is capable of being used as filler for utility application products, such as construction materials, decorating agent, adhesives and insulating materials.
## A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both national classification and IPC:

- C22B1/00
- C08J11/00
- C22B7/00
- C22B9/16
- C22B15/00

## B. FIELDS SEARCHED

**Minimum documentation searched** (classification system followed by classification symbols)

- C22B
- C08J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched:

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used):

- EPO-Internal
- WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.

| X | See patent family annex. |

*Special categories of cited documents:

- **A** document defining the general state of the art which is not considered to be of particular relevance
- **E** earlier application or patent but published on or after the international filing date
- **L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another claim or other special reason as specified
- **O** document referring to an oral disclosure, use, exhibition or other means
- **P** document published prior to the international filing date but later than the priority date claimed

- **T** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- **X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- **Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- **A** document member of the same patent family

**Date of the actual completion of the international search**

31 January 2017

**Date of mailing of the international search report**

08/02/2017

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