Proposition of a PhD position in the framework of the RAP project

Research topic: Improvement and Development of a New Process for Magnet Recycling

Research laboratory: Groupe de Physique des Matériaux (GPM), Université de Rouen Normandie, France, ERMMA group (Magnetic Materials for Applications)

Dates: october 2018 for a period of 36 months

Requirements: Successful candidate will have a master degree in material science (Chemistry of materials, Physics of Materials), a good background in chemistry of materials (synthesis, crystallography, magnetic properties, characterization techniques…), an ability to communicate effectively, a willingness to work in a team. Previous experience in one or more of the specific techniques or related fields described in the following would be an asset: synthesis, nanostructured materials, magnets, electron microscopy, Mossbauer spectroscopy, XRD, recycling techniques.

Details :

Advanced permanent magnets are materials used to convert mechanical-to-electrical energy (and vice-versa) in many electronic applications, especially those requiring miniaturization. These magnets should have a large maximum energy product $(BH)_{max}$ values, which describe their magnetic energy storage. Rare-earth elements such as Sm, Nd and Dy are currently the principle components of strong permanent magnets because of the high resistance to demagnetization (or magnetic coercivity H_c) they convey to the material. These magnets are usually produced from RE containing ores, mainly as byproducts in mining of other elements.

Recent socioeconomic pressures associated with global RE supplies, however, have made it necessary to explore new routes for producing advanced permanent magnets, one of these route is recycling waste electrical and electronic equipment (WEEE) which are called "urban mines''.

In this context, the Groupe de Physique des Matériaux (UMR 6634 CNRS) works on the development of an environmentally- friendly and economically-efficient method for recycling the Nd-Fe-B sintered magnets contained in computer hard disk drives. This work is part of the project ANR-13-ECOT-0006-06 "EXTRADE” (feb- 2014 to July- 2017). This method is based on a solvothermal treatment of the magnets contained in the computer hard disk drives. First results show that the

treatment leads to the removing of the protecting coating, and finally to the obtaining of a fine powder containing grains of magnetic phase [1, 2].

The aim of this PhD proposal is to :

understand the several steps of the process in order to improve it

obtain permanent magnets with powders resulting from recycled powder.

The obtaining of a massive magnet from the powder will be achieved by compacting, sintering or dispersing in a polymer matrix.

All the materials will be characterized by X-ray diffraction, electron microscopy (SEM and TEM), Atom Probe Tomography, Mössbauer spectrometry, Raman spectroscopy and magnetic measurements (VSM and SQUID). The influence of nanostructure on magnetic properties will be identified and interpreted.

This proposal is a part of the ANR-17-CE08-0050-02 “RAP” (jan- 2018 to dec- 2021) and the PhD student will be involved in the tasks of all the project partners : ICMCB laboratory (Bordeaux), CEA – LITEN (Grenoble), ARELEC (Pau) and TRIADE Electronique (Angers).

[1] N. Maât, V. Nachbaur, R. Lardé, J. Juraszek, J.M. Le Breton, An innovative process using only water and sodium chloride for recovering rare earth elements from Nd-Fe-B permanent magnets found in the waste of electrical and electronic equipment, ACS Sustainable Chem. Eng. 2016, 4, 6455-6462
[2] “Process and recovery system for rare earths included in objects” WO application 96/00698 (Oct. 2015)
https://www.google.com/patents/WO2017067844A1?cl=fr

Contact :

Associate Professor Virginie NACHBAUR (virginie.nachbaur@univ-rouen.fr)

Closing date for application: 05/07/2018