Recycling of RE Magnets

The REMANENCE Project

Dr. Vicky Mann

http://repromag-project.eu/
(FP7 project - Rare Earth Magnet Recovery for Environmental and Resource Protection) Finished on 30th of June 2016

The organisations involved in the consortium are:

- C-Tech Innovation Ltd,
- The University of Birmingham,
- Stena Technoworld AB,
- ACREO Swedish ICT AB,
- Leitat Technological Centre,
- OptiSort AB,
- Chalmers Industriteknik,
- Magneti Ljubljana,
- Kolektor Magnet Technology GMBH.
Aims:

• To identify sources of scrap electronics containing NdFeB magnets

• To assess the form of the scrap

• To develop detection and separation technologies to remove the magnet containing parts of the scrap

• To develop a route to extract the materials from the waste streams – i.e. Hydrogen route

• To reprocess the extracted materials into conventionally sintered and injection moulded polymer bonded magnets
## Possible Sources of Scrap

<table>
<thead>
<tr>
<th>Scrap source</th>
<th>Service life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard disk drives</td>
<td>5-10 years</td>
</tr>
<tr>
<td>Loud speakers</td>
<td>5-10 years</td>
</tr>
<tr>
<td>Mixed electronics</td>
<td>5-10 years</td>
</tr>
<tr>
<td>Pumps</td>
<td>?</td>
</tr>
<tr>
<td>Motors and generators in hybrid &amp; electric vehicles</td>
<td>15 years</td>
</tr>
<tr>
<td>Generators in wind turbines</td>
<td>20 years</td>
</tr>
<tr>
<td>MRI scanners</td>
<td>15 years</td>
</tr>
</tbody>
</table>
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Manual Dismantling of a HDD

- Screw
- Spindle motor containing resin bonded NdFeB magnet
- Casing
- Disk
- Voice Coil Motor
- Sintered NdFeB Magnet
- Voice Coil Assembly
- Screws

Workshop in the frame of the World Resources Forum – 25 October 2017

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Shredded HDDs

Industrial shredder - Image provided by Rene Kleijn, University of Leiden, Van Gansewinkel Group

NdFeB powder

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Hydrogen Processing of NdFeB

Hydrogen Decrepitation Process (HD) Developed by Professor Rex Harris, UoB

Cast NdFeB exposed to hydrogen at 1bar absolute and RT.
Time in min:sec

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Hydrogen Processing of Sintered NdFeB

Back scattered SEM image of a cross section from a NdFeB magnet

Room Temperature, 1 bar H₂. Total video time – 40 min

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Voice coil assembly extracted from hard drive

Voice coil assembly after HD process at 7 bar and 170° C

Ni electroplated voice coil magnet

Ni electroless plated voice coil magnet

Soft magnetic Fe casing

Hydrided NdFeB powder

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Detection of Magnet Containing Scrap
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Segregation

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Demonstration Sorting and Cutting Line

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Prototype Reactor for Separation of NdFeB Magnets from WEEE

- Hydrogen vessel
- Valve set
- Collection vessel
- Hard disk drives loaded into porous drum
- Porous rotating stage inside vessel

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Production of NdFeB Powder from Scrap HDDs

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Purification of Recovered Powder

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Compositional Range of HDD Magnets

Dy content of 80 hard disk drive magnets. Each symbol is a different manufacturer. Analysis performed at Leitat.
• The extracted HD powders have been converted into conventional sintered NdFeB magnets with magnetic properties which are comparable to primary NdFeB magnets (a maximum energy product of 295kJ/m$^3$ variation in magnetic properties across batches has been less than +/-5kJ/m$^3$)

• The extracted HD powders have also been converted in HDDR powder at UoB which has been injection moulded into NdFeB magnets (5kg scale a maximum energy product of 62kJ/m$^3$ variation across batches +/- 0.5 kJ/m$^3$)
Thank you
Dr Vicky Mann

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