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Screening Of Different Microorganisms for the Biological Leaching of Rare Earth Elements from Fluorescent Phosphor

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Extended Abstract

Rare earth elements (REE) are used in mostly all new technologies and until now, there exists no environmentally friendly recycling-process for fluorescent phosphor (FP). Furthermore, China has with a worldwide market share of 94 % (Roskill, 2011) a virtual monopoly in the production of REE. Therefore, there is increasing demand for novel recycling technologies to secure the supply of REE. During recycling of energy-saving bulbs annually 175 tons of FP are collected as a distinct fraction (Gallenkemper and Breer 2012, Riemann 2014). It contains about 10% of REE-oxides, which are bound in the hardly water-soluble triband dyes as oxides, phosphates and aluminates (Hauke et al., 2014).

In this study the feasibility of the solubilisation of triband dyes by bio-hydrometallurgical techniques is examined. Due to electrochemical restrictions, leaching with organic acids and metal binding molecules is more promising, than oxidation or reduction reactions (Evans 1990, Morss 1985). On this basis and the literature (e.g. Krebs et al., 1997), different auto- and heterotrophic aerobic microorganisms are selected. With these strains two weeks lasting batch-experiments were performed. The concentrations of several metal ions of the triband dyes in the supernatants were measured by ICP-MS. Furthermore, the produced organic acids were analysed by HPLC.

With "classical" bio-leaching organisms no relevant leaching success could be achieved, since the pH-value in the media was increased by the FP, thus inhibiting the growth of microorganisms. In contrast, some chemo-organoheterotrophic species were able to solubilize REE-compounds. Particularly the bacteria *Komatogateibacter xylinus*, *Lactobacillus casei* and the yeast *Yarrowia lipolytica* turned out to be suitable. Common for all these strains is the lowering of the pH-value during the cultivation due to the production of organic acids (e.g. acetic, lactic or citric acid). Therefore, the underlying mechanism of triband dye solubilisation is probably connected with the carboxyl-functionality. Additionally it is conspicuous, that in all approaches especially the red dye yttrium europium oxide is affected. This is presumably because of the higher solubility of oxides in comparison to phosphates and aluminates in general.

These results show that it is possible to dissolve the REE-compunds of FP by the help of microbial processes. Moreover, it provides the basis for the development of an eco-friendly alternative to the currently applied methods.

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