SUCCESS STORY

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FuLIBatteR
Future Lithium Ion Battery Recycling for Recovery of Critical Raw Materials

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SELECTIVE RECOVERY OF METALS FROM LITHIUM-ION BATTERIES USING METAL-BINDING PEPTIDES

IDENTIFICATION AND CHARACTERIZATION OF METAL-BINDING PEPTIDES FOR THE SELECTIVE RECOVERY OF METALS FROM POLYMETALLIC LEACHING SOLUTIONS

Lithium-ion batteries present the driving force of e-mobility and consist of lots of economically relevant and critical raw materials, like nickel, cobalt, manganese, or lithium. However, the complex composition makes the recycling very challenging. Using microorganisms, in a process called bioleaching, metals from the active material (mechanical and thermal treated lithium-ion batteries) can be transformed into soluble metal ions. The resulting polymetallic solutions served as the starting material for this study, in which the potential of metal-binding peptides for the selective recovery of these metals was analyzed.

Simple peptide structures consisting of only a few amino acids can form small pockets where tiny elements like metal ions can fit. Depending on the amino acids, peptides occur in a wide variety of forms. Bacteriophages were used to find the best metal-binding peptides. Bacteriophages are viruses specialized in infecting bacteria. A different peptide sequence was attached to each phage using molecular biology. This allows screening a billion different peptides, using a technique called phage display, for specific metal binders. The phages are then brought into contact with metal ions, and the ones with a perfectly shaped peptide pocket will bind to the metal ion while all others are washed out (Figure 1). The blueprint of the strong binding peptides can be analyzed from the bacteriophage genome.

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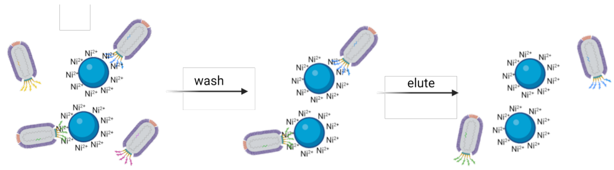

Fig. 1: Schematic phage display workflow. The different peptides are highlighted in yellow, green, blue and pink. (Source: K1-MET)

Using this approach two potential nickel-binding peptides were identified, and their binding was evaluated compared to the wildtype phage without any peptide on the surface. For the application of peptides for the recycling of metals from lithium-ion batteries, the peptides should be phage-free. Therefore, the two peptides were synthesized chemically. In cooperation with the Helmholtz Institute Freiberg for Resource Technology (HIF) preliminary experiments were performed to determine the thermodynamic parameters of the binding events between the peptides and metal ions. Both nickel binding peptides showed good binding affinities to nickel, while the binding to chemically similar cobalt was weaker.

Impact and effects

Two promising nickel-binding peptides were identified, and good binding affinities to nickel were determined in experiments. The preliminary results indicate that these peptides can be used to selectively separate nickel from cobalt and other metal ions from polymetallic leaching solutions. Future experiments will focus on the identification of specific peptides for cobalt and manganese. Attaching the peptides to a suitable carrier material will make it possible to recover specific metals from complex solutions.

Project coordination (Story)
Dipl.-Ing. Anna Sieber
PhD Researcher
K1-MET GmbH

anna.sieber@k1-met.com

FuLIBatteR/Project 3
K1-MET GmbH
Stahlstraße 14
4020 Linz
T +43 (0) 732 - 6989 75607
office@k1-met.com
www.k1-met.com/modul_fulibatter

Project partner

- acib GmbH, AT
- Audi AG, DE
- BRAIN Biotech AG, DE
- Coventry University, UK
- Saubermacher Dienstleistungs AG, AT
- University of Natural Resources and Life Sciences, AT
- voestalpine High Performance Metals GmbH, AT
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