



Fakulteta za
strojništvo

Novodobni odpadki – Litijske baterije

Žiga Jelen, mag. in prof. dr. Rebeka Rudolf



Univerza v Mariboru

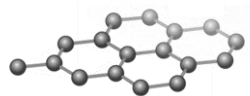
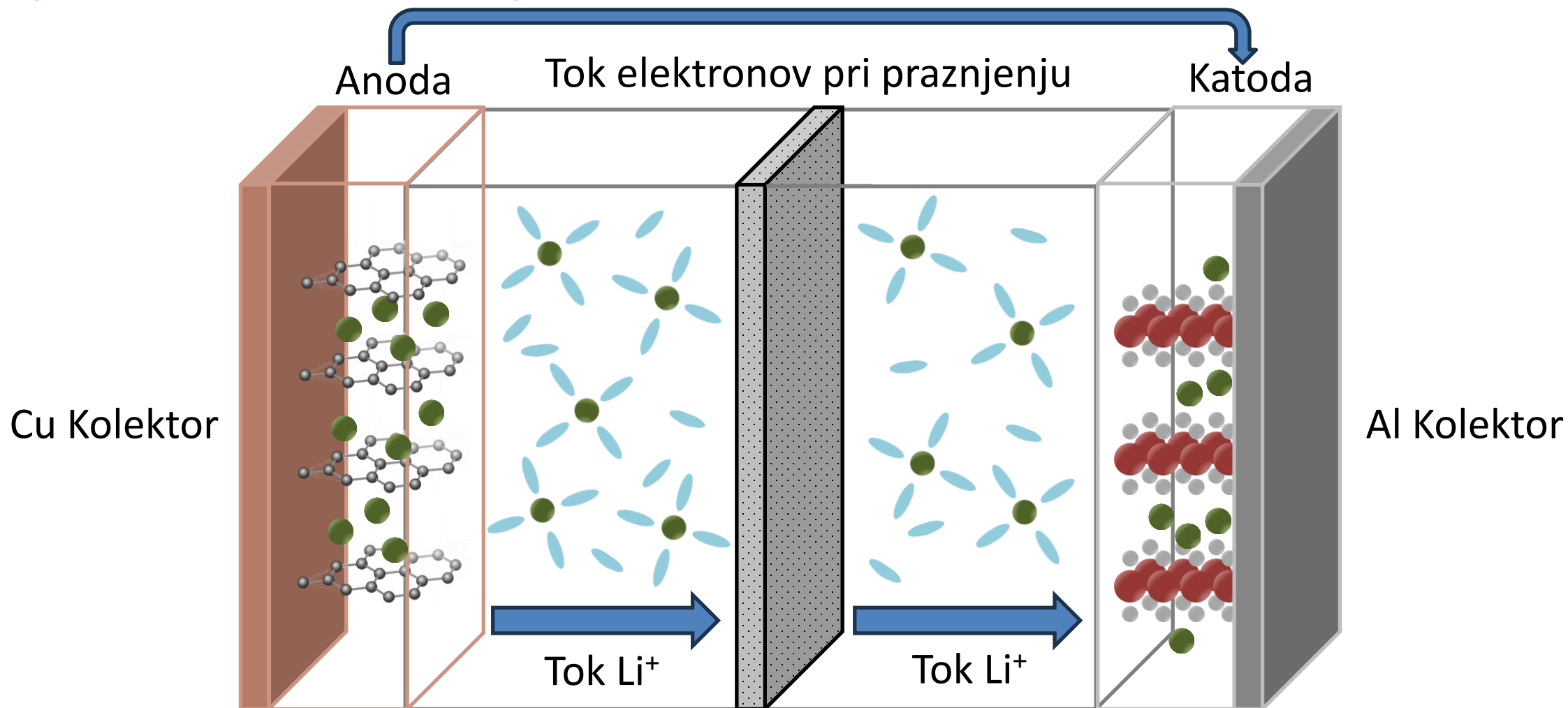


REPUBLIC OF SLOVENIA
MINISTRY OF COHESION AND REGIONAL DEVELOPMENT



Norway
grants

Litij ionska baterija



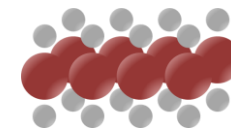
Grafen



Litijev katijon



Elektrolit



Katodni material

Litijeve baterije

Katodni material:

- LiCoO_2 (LCO),
- LiMnO_2 (LMO),
- LiNixCoyMnzO_2 (NCM),
- LiFePO_4 (LFP)

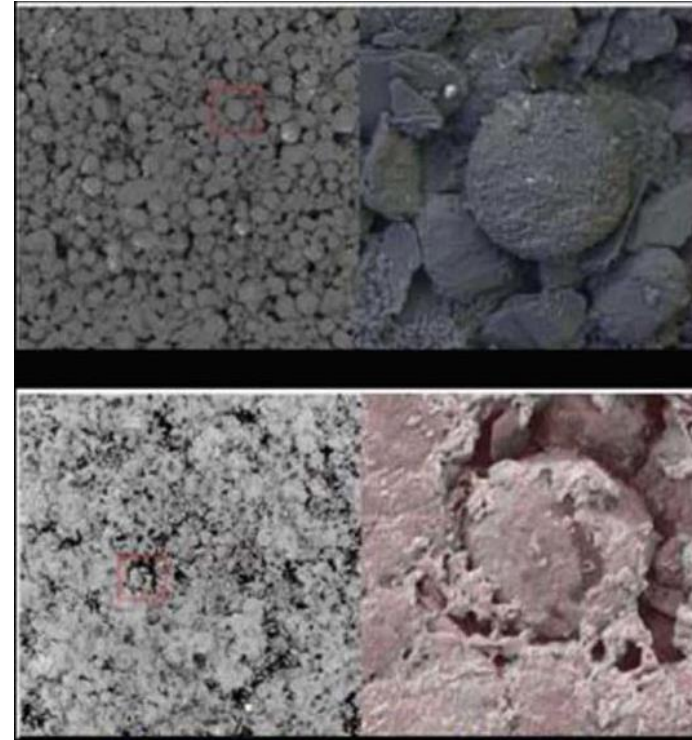


Viri slik: <https://www.dnkpower.com>
<https://www.amazon.com>
<https://www.sparkfun.com>
<https://www.santansolar.com>
<https://www.autocarpro.in>

Življenjska doba

- Pametni telefoni: 1-2 leti
- Pametna elektronika: 1-2 leti
- Prenosni računalniki: 2-4 leta
- Električni skuterji: 1-3 leta
- Baterije za orodje: 2-5 Let
- Električna vozila: 8-10 let
- Hišne baterije: 8-10 let

Katoda



- Degradacija anode in katode
- Razpad elektrolita
- Izločanje Litijevih ionov kot kovinski litij

Vir slike: T. Waldmann *et al.*, "Review—Post-Mortem Analysis of Aged Lithium-Ion Batteries: Disassembly Methodology and Physico-Chemical Analysis Techniques," *J. Electrochem. Soc.*, vol. 163, no. 10, pp. A2149–A2164, 2016, doi: 10.1149/2.1211609jes.

Sestavni materiali

- 5-20 % Kobalta
- 5-10 % Niklja
- 5-7 % Litija
- 5-10 % Bakra
- 5-10% Aluminija
- Železo
- Grafit
- Elektrolit

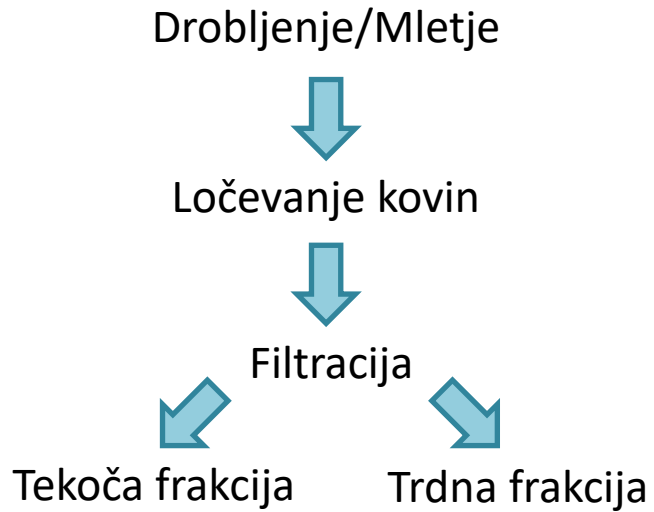


- Vrednost kovin cca. 7000 €/t

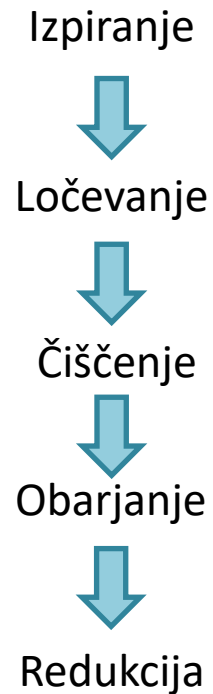
Vir slike: <https://www.adambender.info>

Metode reciklaže

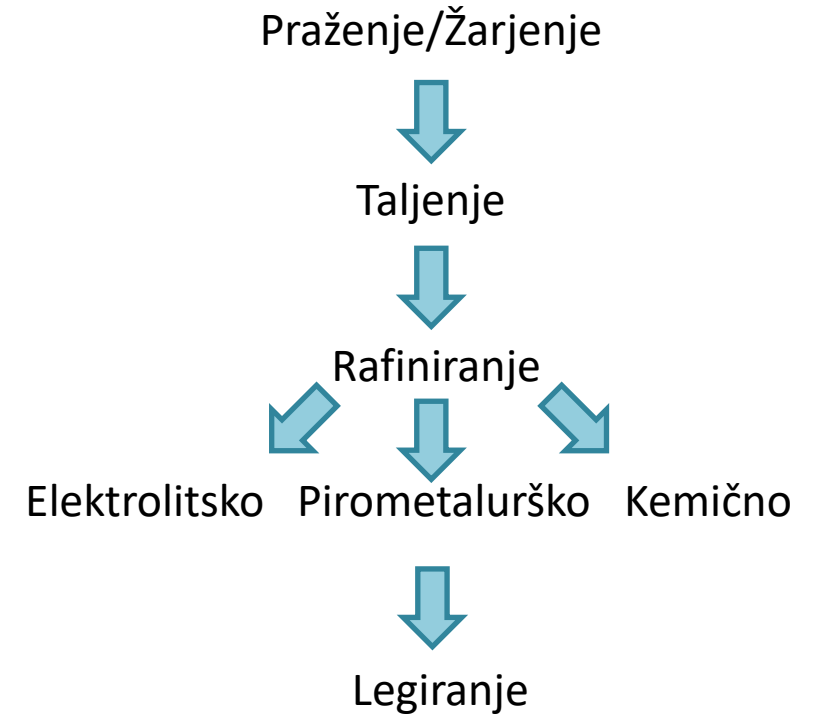
Mehanska Reciklaža



Hidrometalurgija



Pirometalurgija

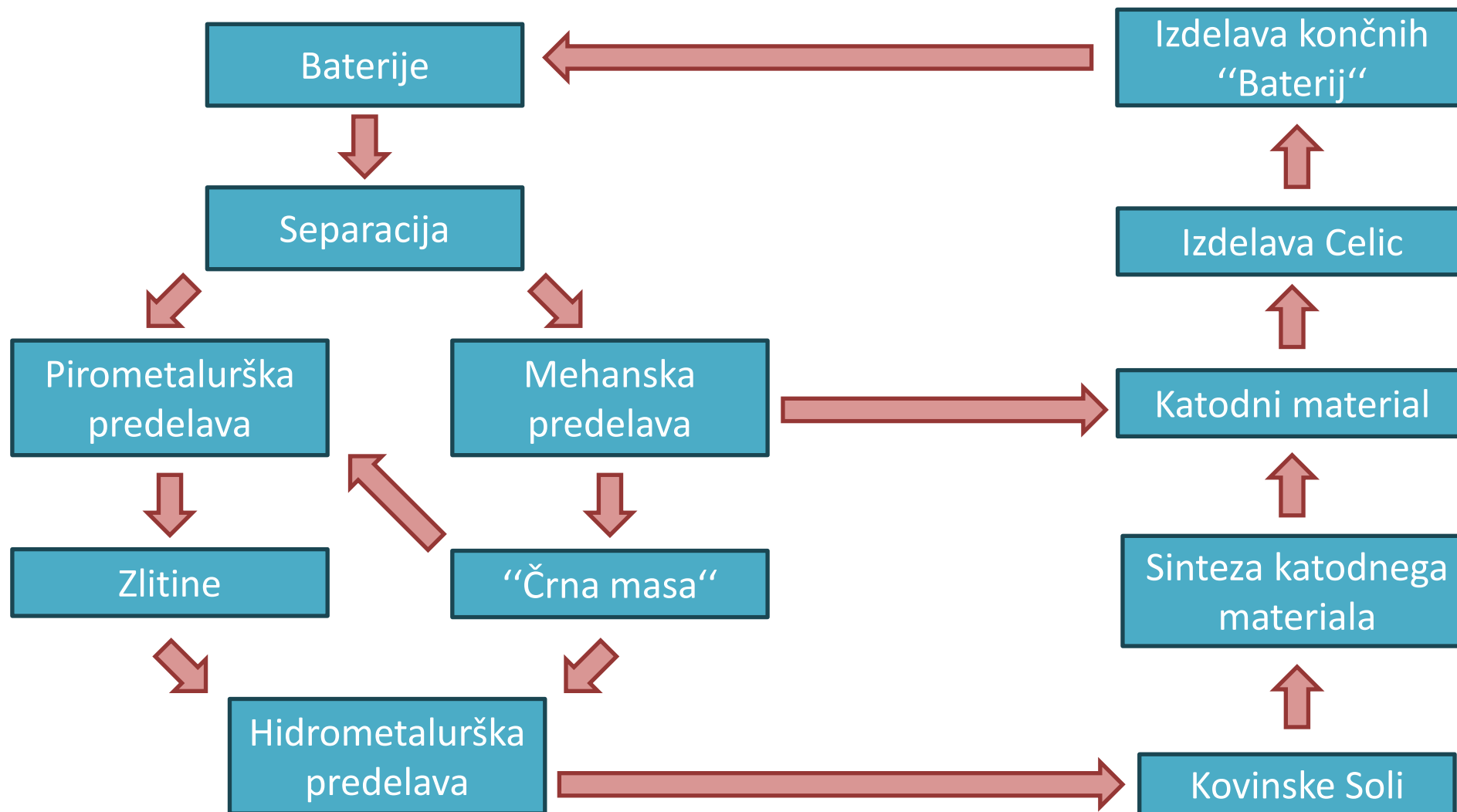


Nevarnosti

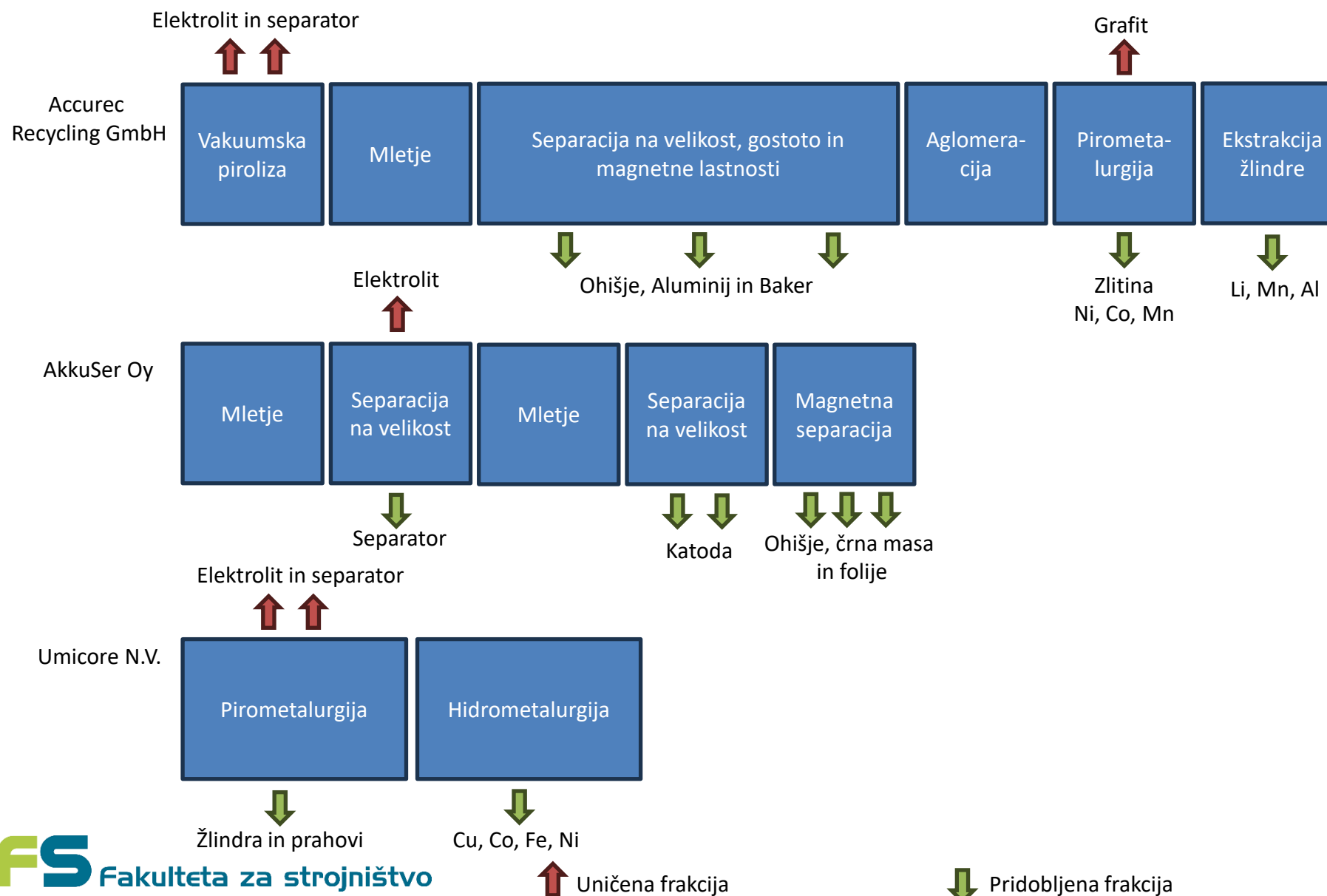
- Požari
- Toplotni pobeg
- Nevarnost eksplozije
- Izpostavljenost kemikalijam
- Električni udar
- Strupeni hlapi
- Puščanje elektrolita
- Navzkrižna kontaminacija katod
- Nevarno delovno okolje
- Vpliv na okolje



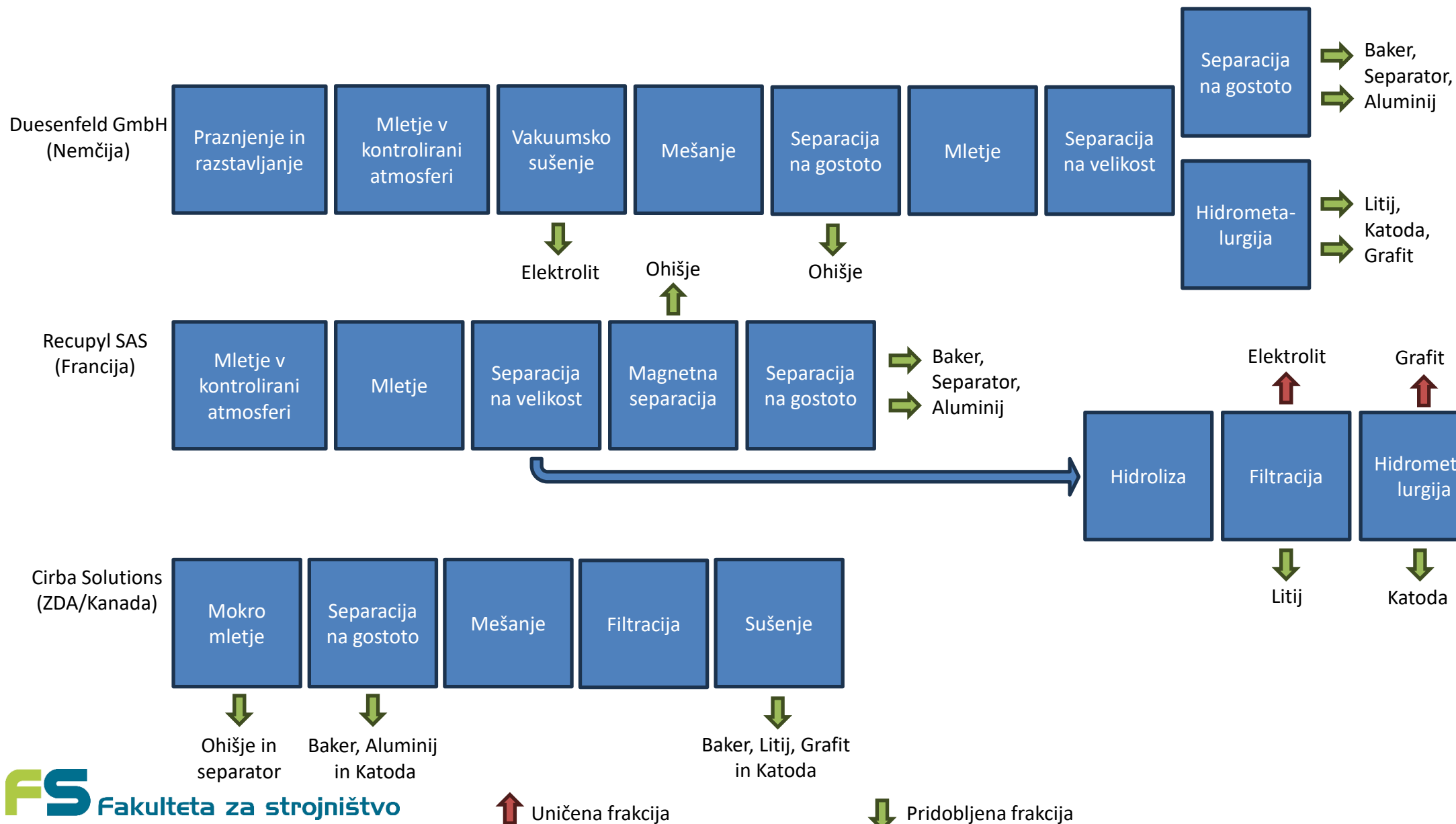
Metoda reciklaže



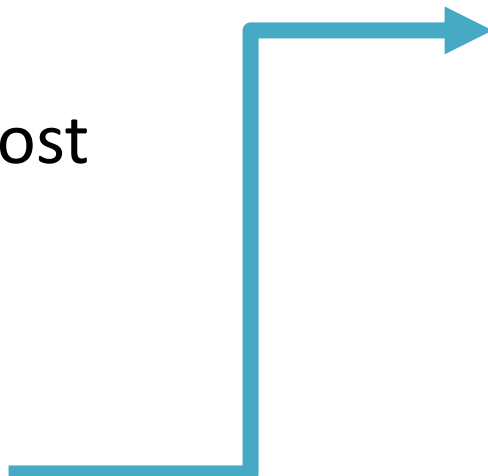
Primeri postopkov reciklaže



Primeri postopkov reciklaže



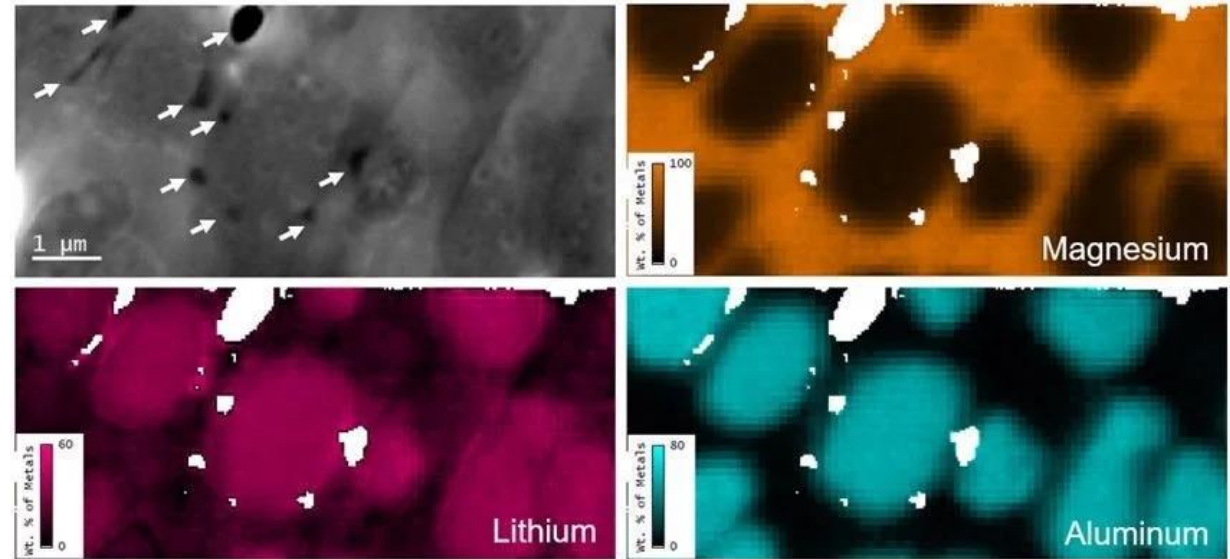
Ključna vprašanja pri zasnovi sistema reciklaže

- Ekonomičnost
 - Energijska učinkovitost
 - Varnost
 - Okoljski vpliv
 - Kakovost reciklatov
- 
- Direktna detekcija Litija v spojinah je zahtevna
 - Atomska absorpcijska spektroskopija (AAS)
 - Induktivno sklopljena plazma (ICP-OES)
 - Plamenska fotometrija

Nedestruktivne metode detekcije Litija



$K\alpha_1 = 54,3 \text{ eV}$



- Rentgenska fotoelektronska spektroskopija (XPS)*
- Rentgenska fluorescenca z disperzijo valovne dolžine*
- Elektronska mikroskopija s Soft X-ray (SXES) detektorju
- Rentgenska difrakcija (XRD)* – (Indirektna zaznava)
- Elektronska mikroskopija z brez okenskim EDS Detektorju

Vir slike: <https://www.azom.com>, The Mapping of Lithium in a Scanning Electron Microscope (SEM)

Pomembnost reciklaže

- Projekcije napovedujejo porast porabe litija na 1,79 milijon ton do 2030
- Ocenjena lanska (2022) globalna poraba Litija je bila 134,000 ton
- Poraba 2021 je znašala 95,000 ton

- Ocenjena lanska (2022) poraba kobalta je znašala 187,000 ton
- 72 % tega je bilo samo za proizvodnjo baterij

HVALA ZA POZORNOST

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MINISTRY OF COHESION AND REGIONAL DEVELOPMENT

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