Characterization of a new Cu selective resin for the separation of Cu from Ni and Zn targets

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Introduction

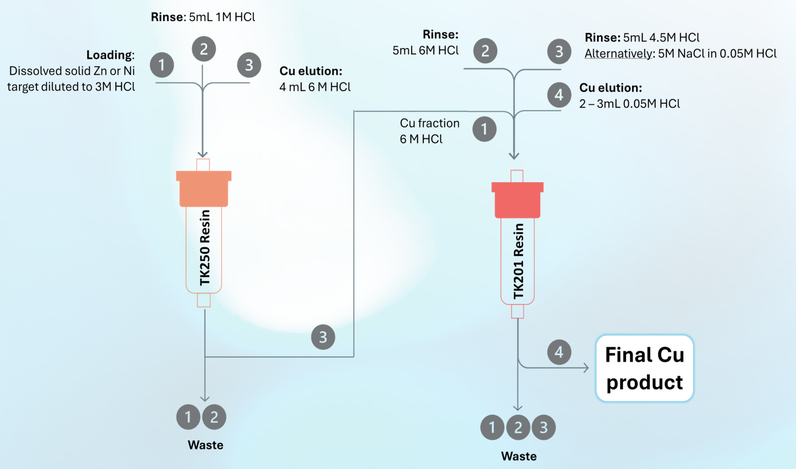
While the separation of Cu isotopes from irradiated solid Ni targets dissolved in HCl is readily feasible [1], their separation from dissolved Zn targets is more difficult to achieve. Commercially available CU Resin [2] is frequently used in this context [3, 4]. While it shows high selectivity for Cu over Zn (and other transition metals) it has the drawback of requiring loading at a pH >2, making a pH adjustment necessary.
A new extraction chromatographic currently under development (TK250 Resin) shows promising selectivity for Cu over Zn, Ni and a wide range of other elements in HCl. Part of the work on its characterization is presented.

Methods

The TK250 Resin was characterized with respect to its selectivity via weight distribution ratio (D_W value) experiments for a wide range of elements and HCl concentrations.
D_W values were determined through batch experiments (50mg TK250 Resin, 1mL multi-element test solutions of defined HCl concentration, 30 min contact time, ICP-MS measurement of the test solutions before and after the extraction).
Further, elution studies were performed using prepacked 2mL TK250 Resin cartridges. Cu (typically 10ppm) was purified from up to 300mg Zn or Ni, respectively. Relevant potential impurities like Ga, Co and Fe were also taken into account.
These studies were performed using 2mL TK250 Resin cartridges and stables elements. 1mL fractions were taken and subsequently analyzed by ICP-OES.
The Cu capacity of the TK250 Resin was determined via dynamic experiments on 2mL TK250 Resin cartridges by monitoring Cu breakthrough, and subsequent elution of Cu from the saturated cartridges.

Suggested separation method

Based on obtained results the method shown below is suggested for the separation of Cu isotopes from solid Zn (or Ni) targets.
Cu is first separated from the target material and impurities on a 2mL TK250 Resin cartridge.
Cu is finally converted to dilute HCl on a TK201 Resin cartridge as described before [1, 3, 4].

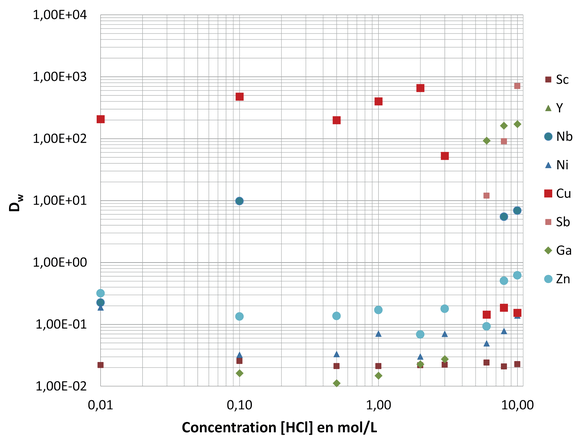


Suggested Cu separation from Ni or Zn targets, based on a 2mL TK250 Resin cartridge and a 2mL TK201 Resin cartridge

Results

Results obtained during resin characterization and method optimization are shown below.

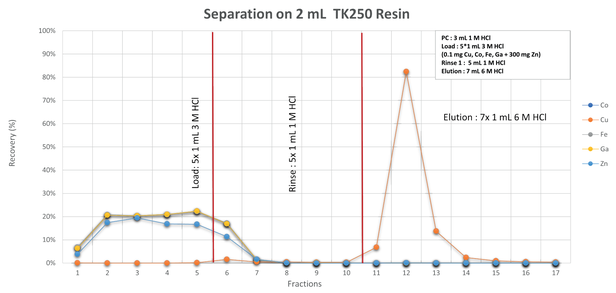
Weight distribution values (D_W)



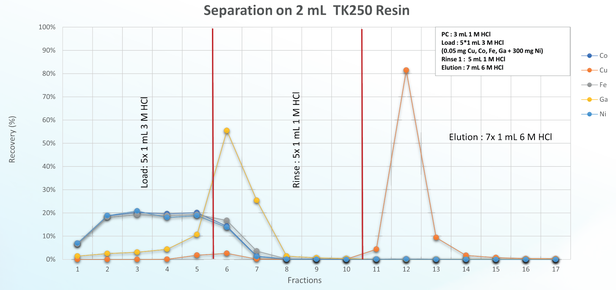
D_W values, TK250 Resin, selected elements, varying HCl concentrations

Cu is very well retained between 0.01M HCl and 3M HCl, at higher HCl concentration the D_W values drop sharply. Potential interferents and target materials are showing very low D_W values at all acid concentrations. Only exception is Ga (and Sb) which is not retained under the conditions Cu is retained, but it is well retained at high HCl concentrations where Cu is eluted. A range of additional elements were tested and shown to be not retained. Information is available upon request.

Elution studies



Elution study, stable elements, 2mL TK250 Resin cartridge, selected elements, 1mL fractions, 10ppm Cu, 300mg Zn



Elution study, stable elements, 2mL TK250 Resin cartridge, selected elements, 1 mL fractions, 10 ppm Cu, 300mg Ni

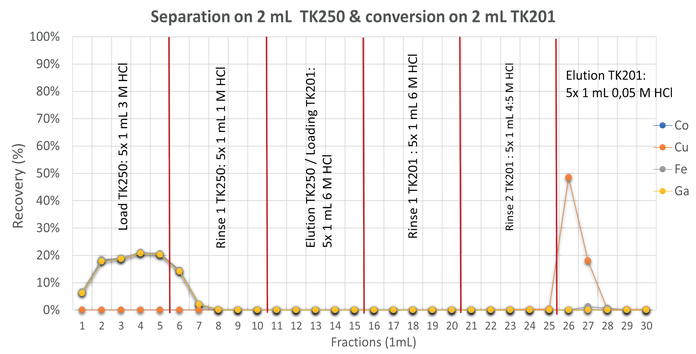
The 2mL TK250 Resin cartridge was preconditioned with 3mL (1.5BV) of 1M HCl. The simulated dissolved targets were loaded on the 2mL TK250 Resin cartridge from 3M HCl. Rinsing with at least 5mL (2.5BV) 1M HCl allows removing impurities and target materials (tested up to 300 mg Zn or 300 mg Ni so far). Cu is finally eluted with 6M HCl in about 4 mL (2BV). Decontamination factors were generally >10^3 and >10^4

Cu capacity determination

Total and breakthrough capacities of the TK250 Resin were determined to be in the order of 0.13mg Cu / g of TK250 Resin, which is lower than typically observed for other extraction chromatographic resins.

Conversion of Cu fraction on TK201

Cu is eluated from TK250 Resin in 6M HCl which is too acidic for use in radiolabeling. Like in the case of Cu purification on CU Resin, TK201 Resin may be used for conversion of the Cu product to low HCl concentrations. The graph below shows an example of a separation of Cu from 300mg Zn, followed by the conversion to 0.05M HCl via TK201 Resin.



Elution study, stable elements, 2mL TK250 Resin cartridge, 300 mg Zn, selected elements.

Conversion of Cu eluate on 2mL TK201 cartridge

Overall, a clean Cu fraction can be obtained in 2 – 3mL of dilute HCl.
Beta testing of the TK250 Resin, including the TK201 conversion step is currently on-going.

Conclusions

> A new extraction chromatographic resin (TK250 Resin) was characterized with respect to its selectivity in HCl through D_W values
> The resin shows very good selectivity for Cu over e.g. Ni, Zn, Co and Ga at low to elevated HCl concentrations (0.01 – 3M HCl), which may facilitate the separation of Cu isotopes from solid Zn (and Ni) targets.
> Elution studies showed that Cu can be separated from up to 300mg Zn or Ni.
> Cu elution from TK250 Resin is performed with HCl of elevated concentration (6M HCl), suitable for subsequent conversion to dilute HCl via TK201 Resin (under optimisation).
> Beta tests are currently on-going – please contact us for free samples
> Next steps: production upscale and shelf-life determination

References

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[2]CU Resin product sheet, web site TrisKem International,, accessed 02/12/2024
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[4]Kawabata, M., Motoishi, S., Ohta, A. et al. J Radioanal Nucl Chem 330, 913–922 (2021).