PRODUCT SHEET

ZR Resin

Main Applications

- Separation of zirconium
- Separation of titanium

Packing

Order N°.	Form	Particle size
ZR-B25-A, ZR-B50-A, ZR-B100-A, ZR-B200-A	25g, 50g, 100g and 200g bottles ZR resin	100-150 µm
ZR-B25-S, ZR-B50-S, ZR-B100-S, ZR-B200-S, ZR-B10-S	25g, 50g, 100g and 200g bottles ZR resin	50-100 µm

Physical and chemical properties

Capacity : 40 mg Zr/g ZR Resin

Density: 0.34 g dry ZR Resin/mL

Conditions of utilization

Recommended T of utilization : 20-25°C

Flow rate: A grade: 0.6 – 0.8 mL/min, utilization with vacuum or with pressure for s grade resin

Storage: Dry and dark, T<30°C

For additional information see enclosed literature study

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ZR RESIN

The ZR Resin is based on the hydroxamate functionality frequently used for the separation of zirconium, especially from Y target materials for later use in radiopharmaceutical applications.
Dirks et al.[1] characterized the resin with respect to its selectivity for selected elements in HNO_3, HCl and oxalic acid, results are summarized in Figures 1 – 3.

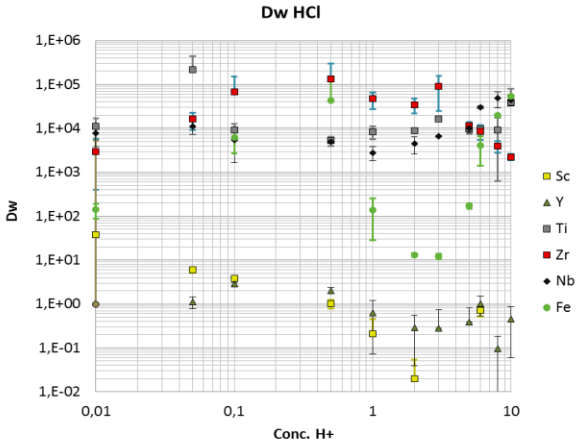

Figure 1 : *D_W values, ZR Resin, HCl, various elements*

The ZR Resin shows high selectivity for Zr, Ti and Nb over a wide range of HCl concentrations (0.01M – 10M), Fe(III) is strongly retained at low and elevated HCl concentrations, retention is weaker from 1 – 6M HCl. As expected the resin shows very little selectivity for Sc and Y, a separation of e.g. Zr from Y and Ti from Sc seems thus feasible.

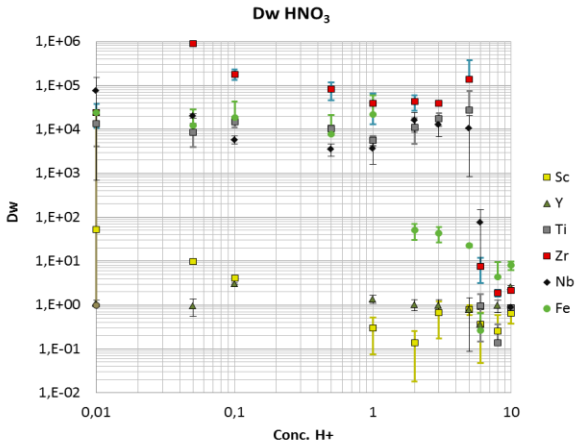

Figure 2 : *D_W values, ZR Resin, HNO_3, various elements*

The resin shows rather similar selectivity in HNO_3, Zr, Ti and Nb are well retained up to 5M HNO_3, Fe(III) is well retained up to 1M HNO_3. At higher HNO_3 concentrations the nitric acid starts attacking the extractant, as indicated by a colour change of the resin from white to brown; accordingly the resin shows no significant selectivity towards the tested cations under these conditions. As in HCl, Y and Sc show no significant retention on the ZR Resin in HNO_3.

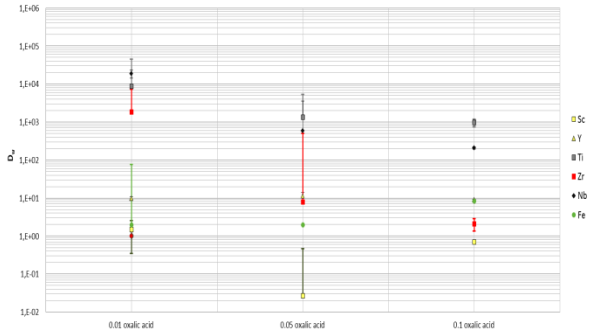

Figure 3 : *D_W values, ZR Resin, oxalic acid, various elements*

Oxalates are very strong complexing agents for Zr, accordingly they are very frequently used for the elution of Zr.
It could be shown that oxalic acid concentrations above 0.05M lower the D_W value of Zr on the ZR Resin strongly; they are thus suitable eluting agents for Zr. It was further observed that Nb shows high D_W values even at 0.05M oxalic acid, indicating that Zr and Nb may be separated by adjusting the oxalic acid concentration accordingly.

Based on obtained D_W values several elution studies were performed[1] with main focus on the use of the resin in the context of radionuclide production for radiopharmaceutical use. Fig. 4 and 5 show the results of these elution studies.

As indicated by the D_W values the ZR Resin can be loaded over a wide HCl concentration range. The rinsing conditions were kept close to the conditions suggested by Holland et al.[2]: after the load the resin is first rinsed with four times 2.5 mL of the same acid used during the load (here 2M or 6M HCl), followed by an additional rinse with four times 2.5 mL water. Zr is finally eluted using 0.1M oxalic acid.

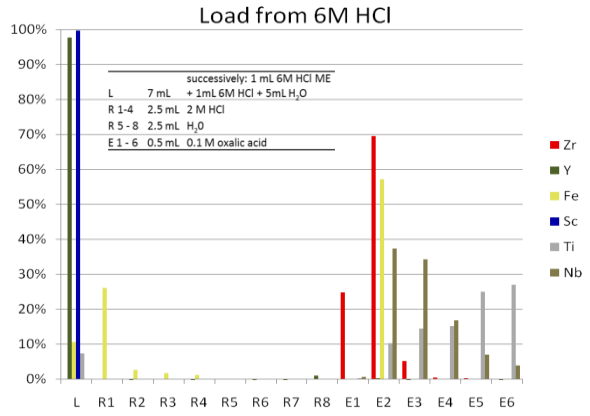

Figure 4 : *Elution study ZR Resin, 100 mg, load from 6M HCl, multielement solution (ME), fractions analysed by ICP-MS*

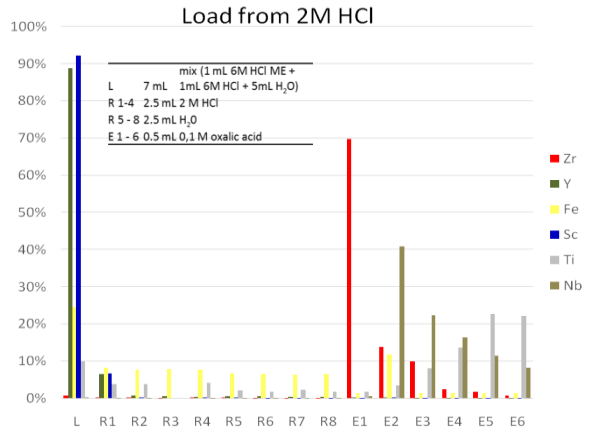

Figure 5 : *Elution study ZR Resin, 100 mg, load from 2M HCl, multielement solution (ME), fractions analysed by ICP-MS*

Under the given conditions a very clean separation of Zr from Y and Sc was obtained, both are breaking through during the loading of the ZR Resin, last traces are removed during the first rinsing steps. Zr can be recovered near quantitatively in 1.5 mL 0.1M oxalic acid even in presence of up to 300 mg stable Y (using a 100 mg ZR Resin column); however no complete Zr/Nb separation could be achieved under these conditions. Ti is only partially eluted under these conditions; in order to remove it quantitatively it will be necessary to apply more suitable elution conditions.

Fig. 3 indicates that a Zr/Nb separation should be possible using 0.05M oxalic acid as eluting agent for Zr, this could be confirmed through elution studies as shown in Fig. 6. In order to quantitatively elute Nb higher oxalic acid concentrations will need to be employed (> 0.2M oxalic acid).

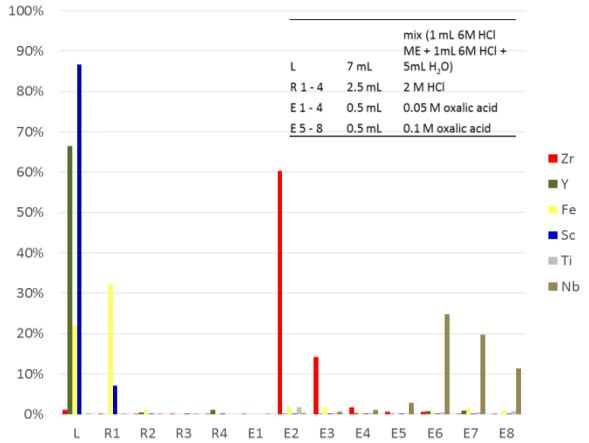

Figure 6 : *Elution study ZR Resin, 100 mg, load from 2M HCl, Zr elution with 0.05M oxalic acid, multielement solution (ME), fractions analysed by ICP-MS*

Fig 4 and 5 further show that Fe(III) will to a certain extend follow Zr this might lead to interferences with labeling reactions; accordingly it might be preferable to remove it from the Zr fraction. One possibility is loading the resin under reducing conditions using suitable reducing agents such as ascorbic acid or hydroxylamine hydrochloride, as can be seen in figure 7.

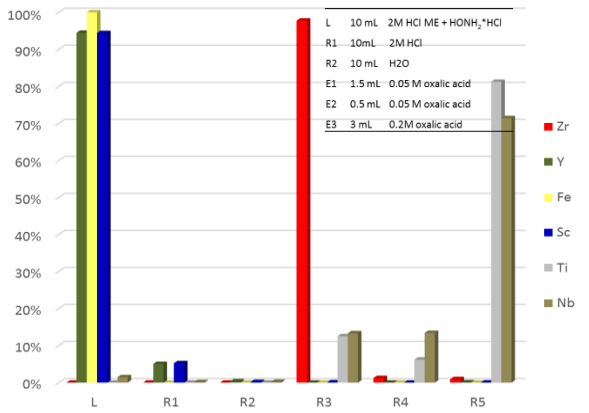

Figure 7 : *Elution study ZR Resin, 100 mg, load from 2M HCl under reducing conditions ($HONH_2$*HCl), multielement solution (ME), fractions analysed by ICP-MS*

Fig 8 schematically shows the suggested Zr purification method.

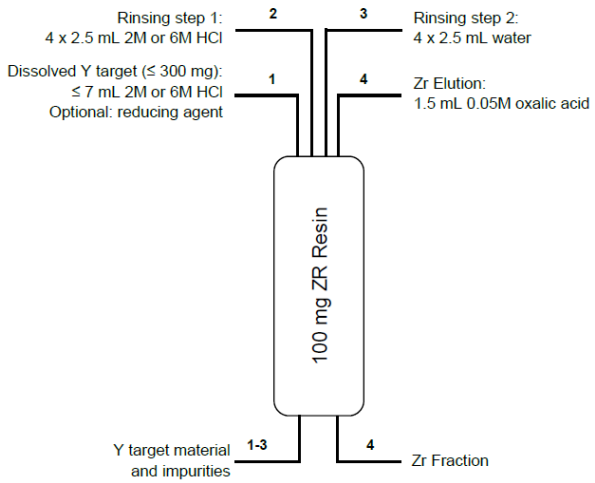

Figure 8 : *suggested method for the separation of Zr from Y targets (≤ 300 mg) using the ZR Resin*

Other than for Zr the ZR Resin also shows very interesting selectivity for Ti, especially with respect to Sc. Fig. 9 shows an example of a Ti/Sc separation performed on the ZR Resin: while Sc is not retained from 10 M HCl Ti is fixed very well. 0.1M citric acid may be used to elute Ti from the resin; however a volume of at least 3 mL will be needed. Beside citric acid, hydrogen peroxide or oxalic acid of elevated concentration may be employed.

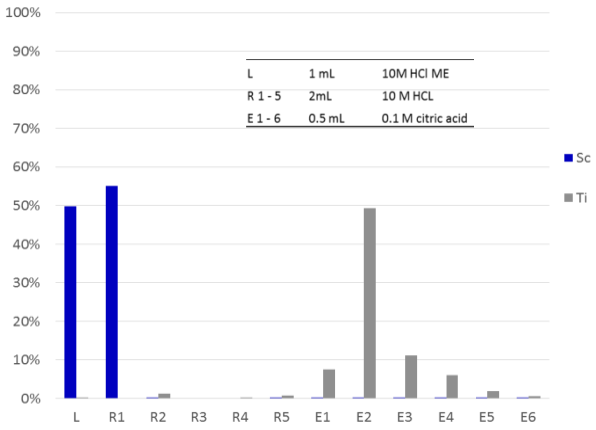

Figure 9 : *Elution study ZR Resin, 100 mg, load from 10M HCl, Ti and Sc, fractions analysed by ICP-MS*

As Ti is retained over a very wide range of HCl concentrations, including dilute HCl, its potential for use as support for a Ti/Sc generator was evaluated. A 100 mg ZR Resin column was loaded with a small volume of a solution containing Ti and Sc. The column was then rinsed five times with 1 mL 0.01M HCl, followed by 10 rinses with 5 mL 0.01M HCl. As shown in Figure 10 Sc is easily removed in a small volume of dilute hydrochloric acid whereas Ti remains retained, the general selectivity of a generator is thus given, however, further testing will be necessary in order to further evaluate Ti breakthrough and purity of the obtained Sc.

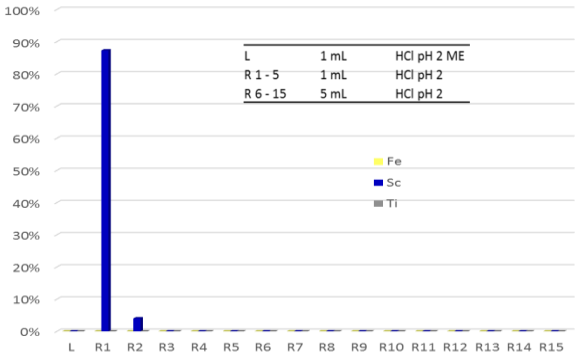

Figure 10 : *Elution study ZR Resin, 100 mg, load from 0.01M HCl, Ti and Sc, repeated elutions, fractions analysed by ICP-MS*

Bibliography

(1) Dirks et al.: “On the development and characterisation of an hydroxamate based extraction chromatographic resin”. Presented at the 61st RRMC, October 25th - 30th, 2015, Iowa City, IA, USA

(2) Jason P. Holland, D.Phil, Yiauchung Sheh, Jason S. Lewis, Ph.D: “Standardized methods for the production of high specific-activity zirconium-89”, Nucl Med Biol., 36(7), 2009, 729–739; doi:10.1016/j.nucmedbio.2009.05.007