eichrom® TECHNOLOGIES
A GCI COMPANY

npo
eichrom

Identification of Eichrom resins using attenuated total reflectance – Fourier transform infrared spectroscopy (ATR-FTIR)

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68th RRMC, Idaho Falls
4 November 2025

Identity Testing

A test to confirm the product received is the product ordered

- Non-destructive
- Small sample size
- Simple and rapid
- Accurate and precise

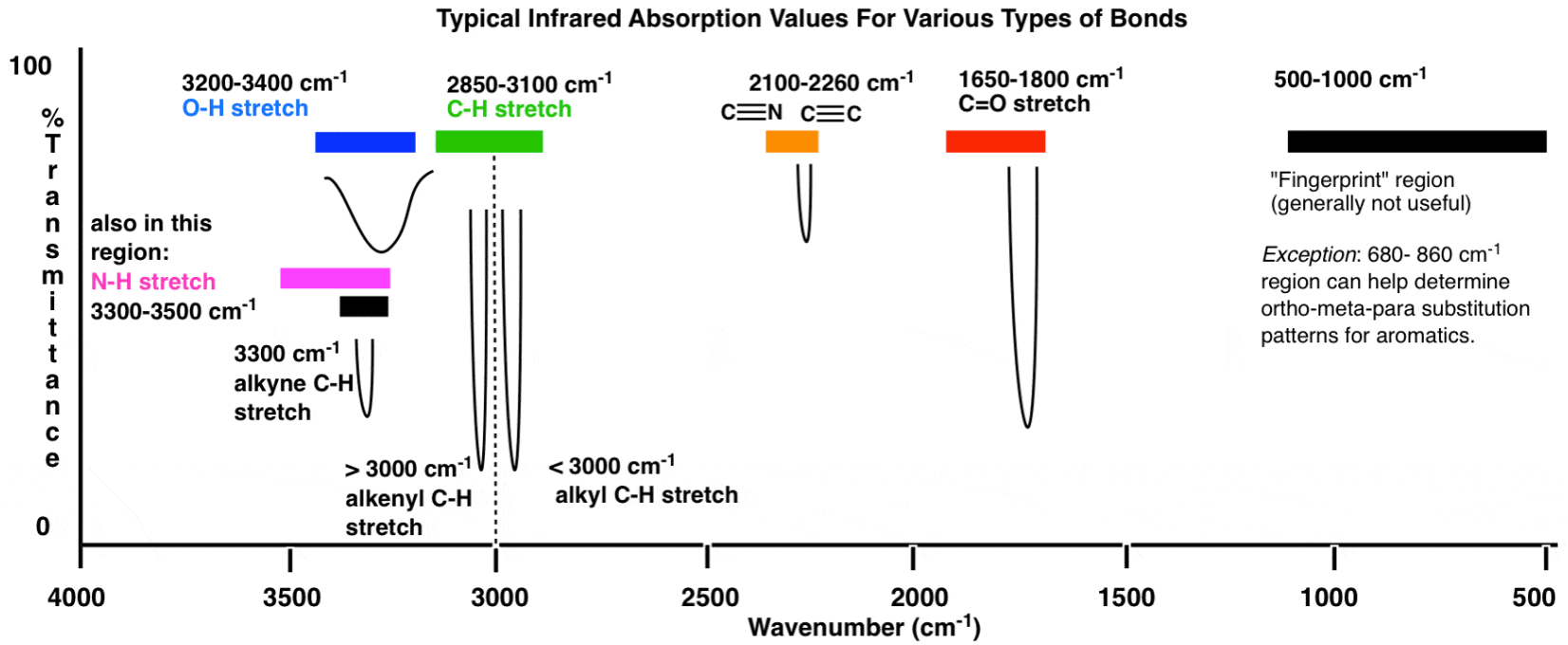
Why does Eichrom care?

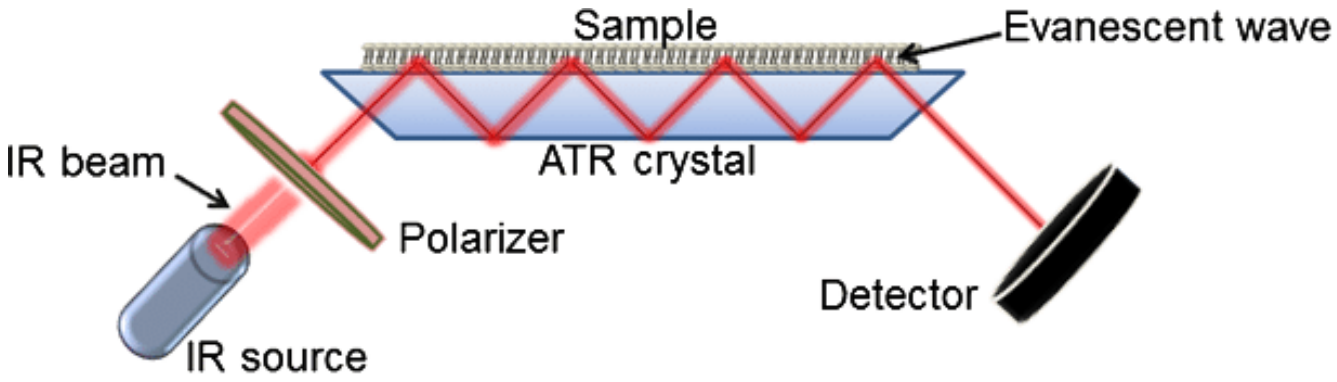
Nuclear medicine customers may require ID testing

- Almost all Eichrom products are visually identical
- Further verification of our own Quality Controls

ATR-FTIR Spectroscopy

- Describe types of chemical bonds in a sample
- FTIR spectra are a unique fingerprint for a specific material
- ATR allows for direct measurement of solid or liquid samples





FTIR spectra of Eichrom resins correspond to the chemical features of the extractant(s), diluent (if present), and solid support (Amberchrom CG71)

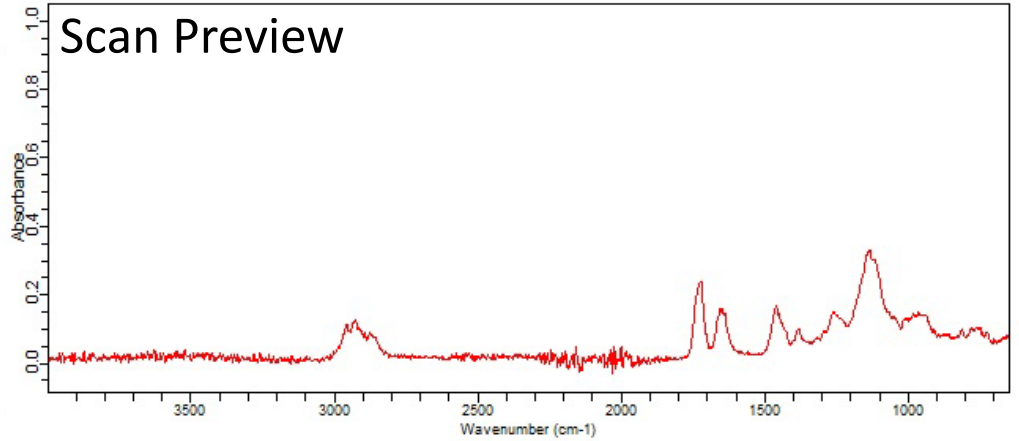
Ausili, A. et al. *Biomed Spectrosc Imaging,* 4**(2)**, 159-170, (2015).
https://www.masterorganicchemistry.com/2016/11/23/quick_analysis_of_ir_spectra/

The Cary 630 FTIR

"Rapidly gain qualitative and quantitative information –

***Identify unknown substances** and determine levels of sample constituents"*

- Portable (3.5 kg, 20x20 cm)
- User-friendly software
- < 2 cm^{-1} resolution
- Modular design
  - **Diamond ATR cell**



Results: Best Library Matches

Rank	Quality	Library	CAS#	Name
1	0.92622	Eichrom extractants and resins (22)		DOODA resin
2	0.92313	Eichrom extractants and resins (20)		DGA-Normal resin
3	0.92130	Eichrom extractants and resins (19)		DGA-Branched resin
4	0.88342	Eichrom extractants and resins (30)		TEVA resin
5	0.87982	Eichrom extractants and resins (27)		Pb resin
6	0.87428	Eichrom extractants and resins (33)		WBEC resin
7	0.86831	Eichrom extractants and resins (29)		Sr resin
8	0.86830	Eichrom extractants and resins (17)		Cl resin
9	0.83217	Eichrom extractants and resins (4)		amberchrom
10	0.83217	Eichrom extractants and resins (16)		amberchrom

Spectrum Matching

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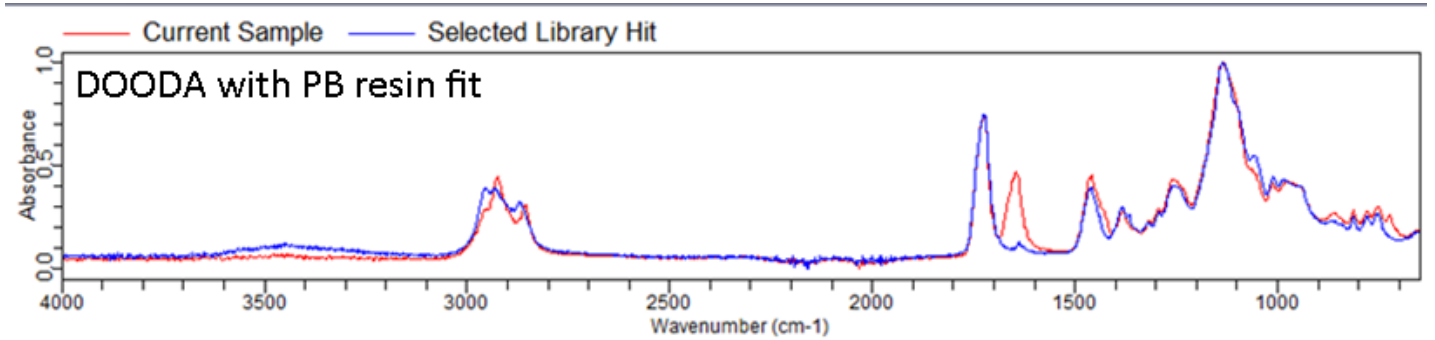
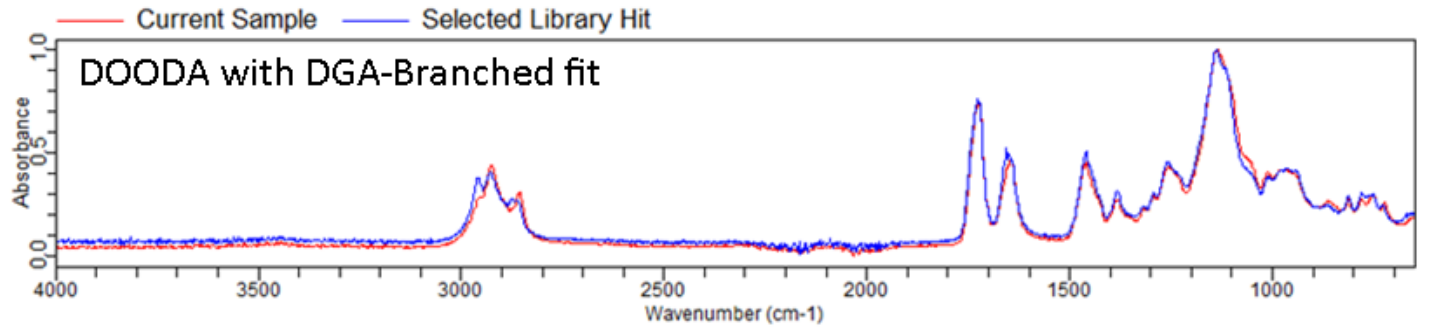
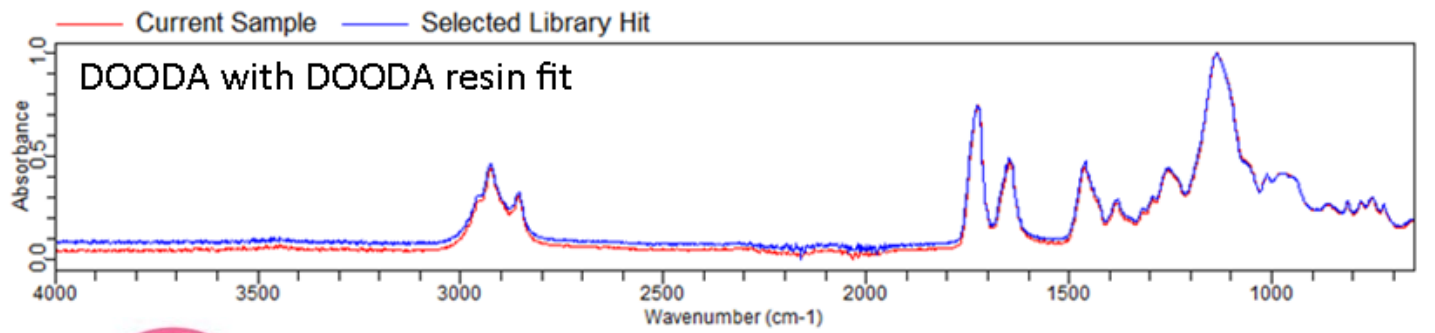
- Software provides its top ten match fits
  - No weight given to peaks vs background
- Some resins are easier to ID than others
- Resins with similar extractants can provide challenges for the software – but not the user!



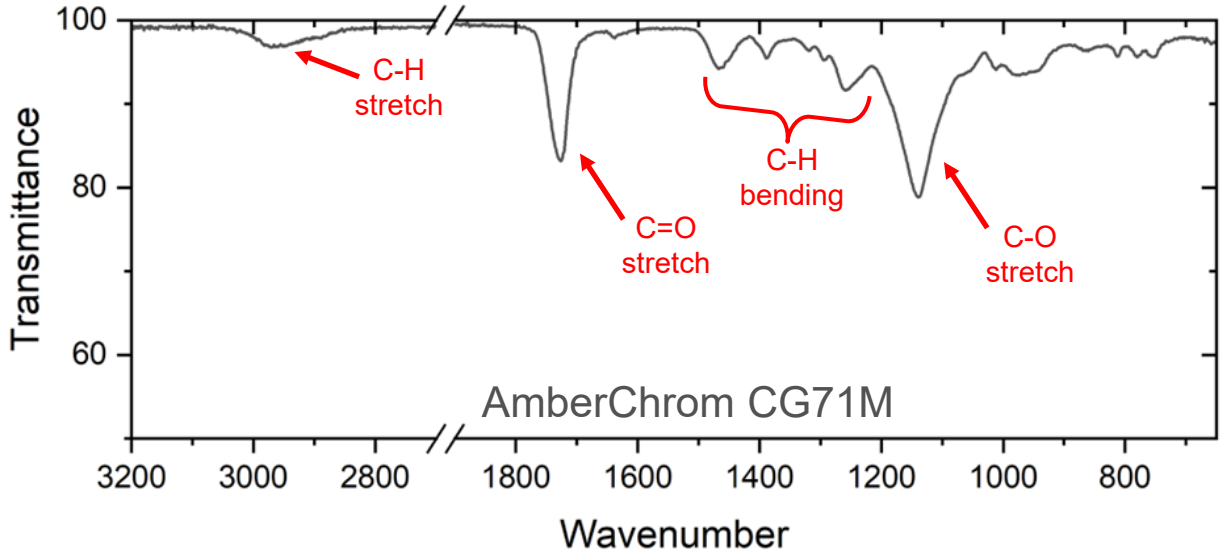


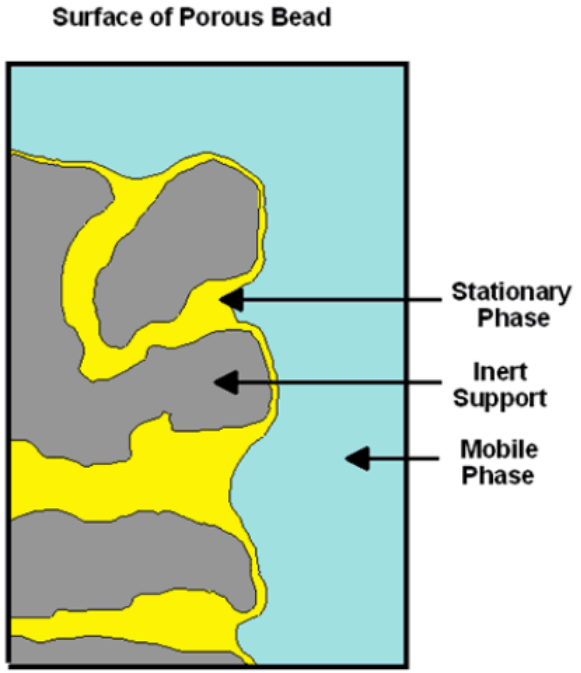


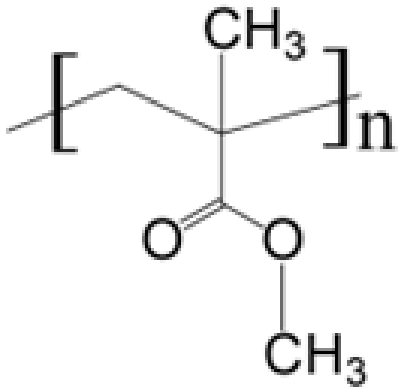
Inert Support

- AmberChrom CG71M
  - Porous aliphatic acrylic ester resin beads
  - Non-specific sorption of organics
  - Sold as “pre-filter” resin

- Eichrom EXC Resins
  - 38.5-40% wt. active ingredients
    - liquid extractant
    - solid extractant + diluent
  - Physiosorbed to AmberChrom



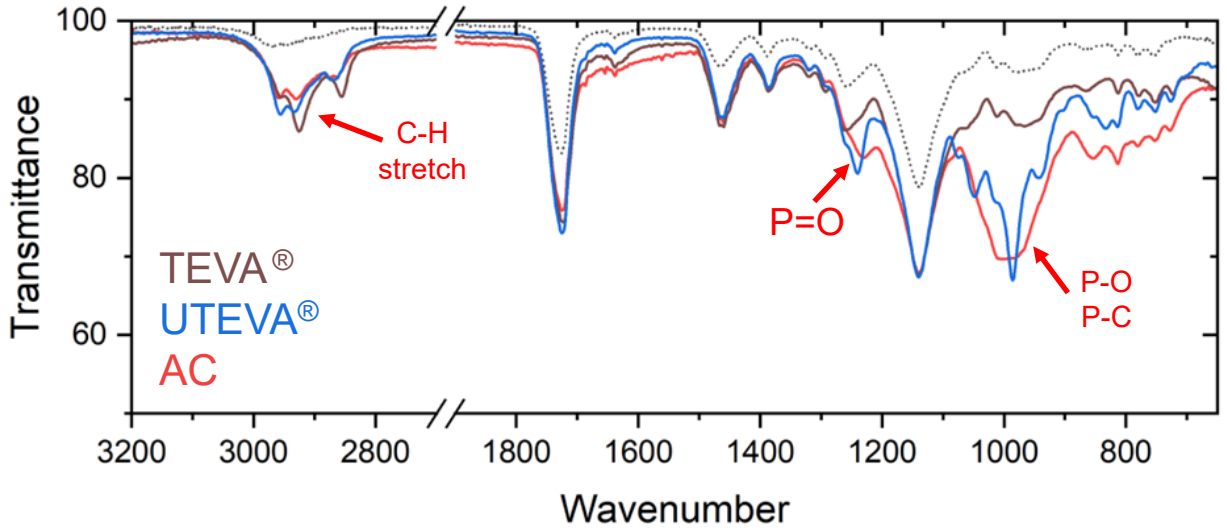




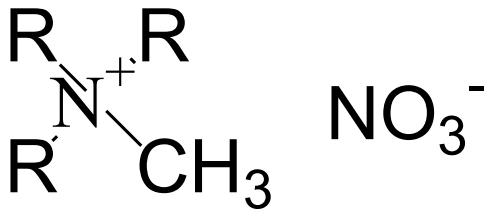
AmberChrom CG71M

Resins for Actinides (AC/TEVA/UTEVA)

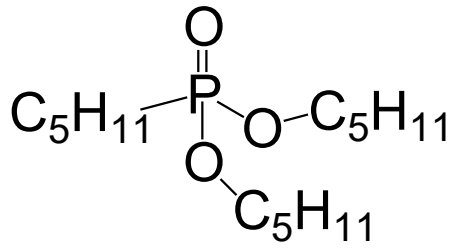
- TEVA
  - Tc, Th, Np, Pu separations
  - Am/Ln separation (SCN)
  - Anion exchange extraction mechanism
- UTEVA
  - Th, Np, Pu, and UO_2^{2+}
  - No affinity for +3 actinides
  - Solvating extraction mechanism
- AC
  - Group actinide separations / gross alpha measurements
  - Ultra-high Dw of lanthanides and +3, +4, and +6 actinides
  - Requires aqueous complexant (HEDPA) to strip



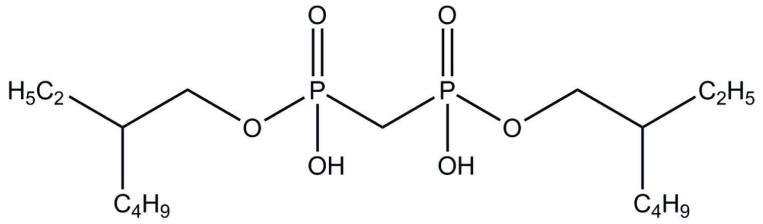
TEVA®



UTEVA®

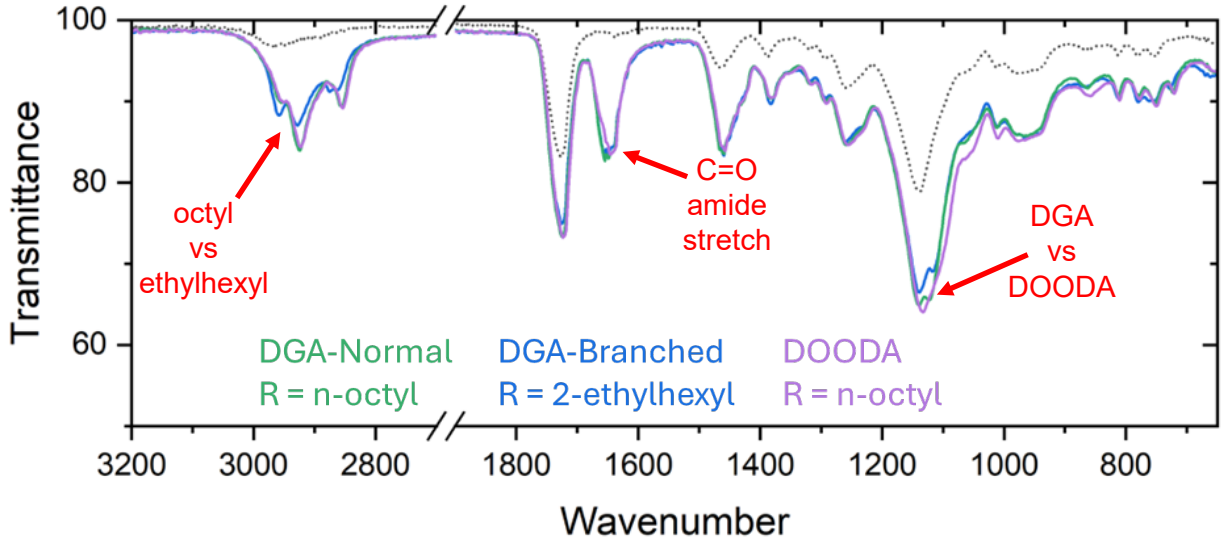


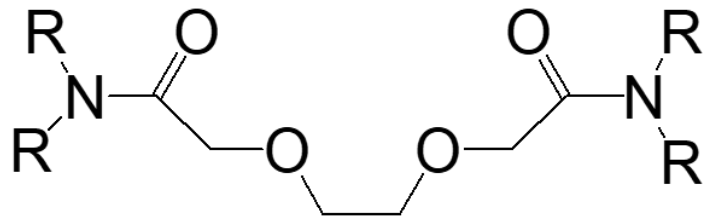
AC



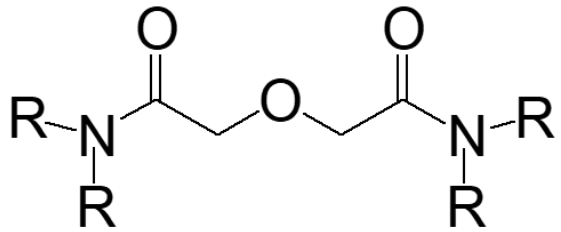
DGA's and DOODA

- DGA-Normal and DGA-Branched
  - Actinides, Lanthanides, Y, and Sc
  - Increased retention of +3 Ln/An
  - Solvating extraction mechanism
  - Unique Ac^{3+}/Ln^{3+} separation at high $[HNO_3]$
- DOODA
  - Eichrom's newest resin
  - Reduced affinity for An/Ln's compared to DGA-Normal
  - Easier to recover high specific activity tracers





DOODA
R = n-octyl

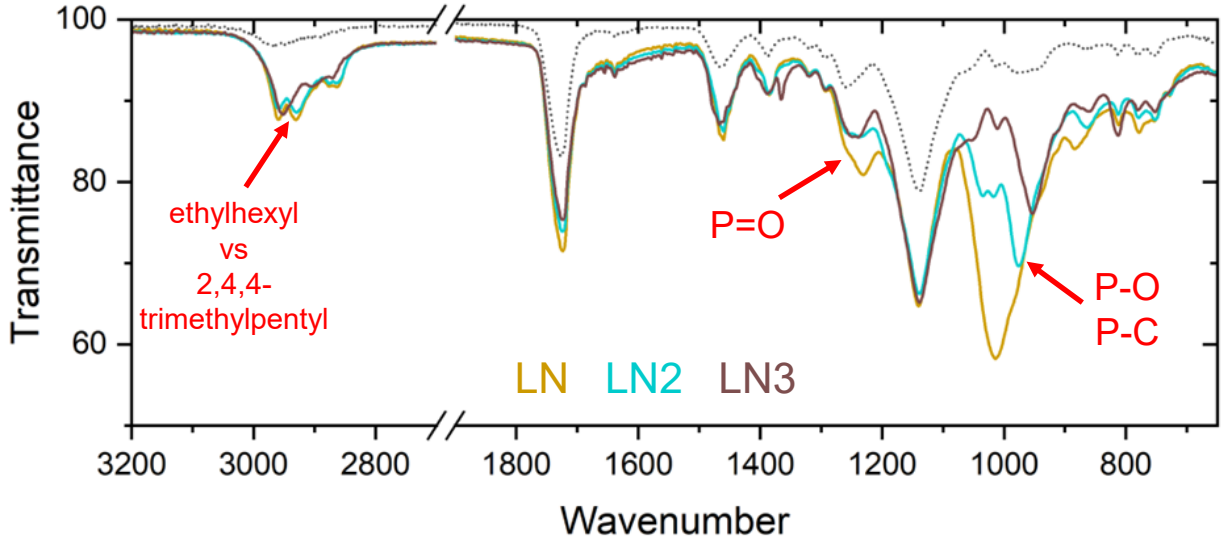


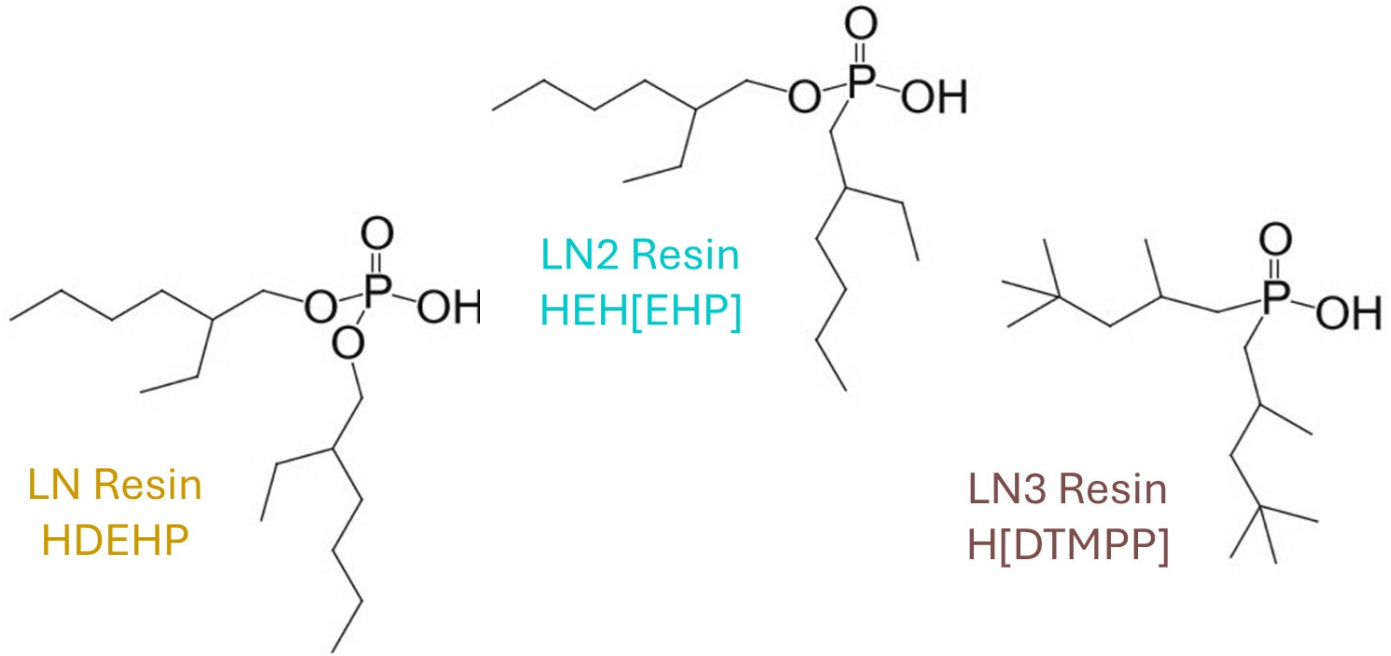
DGA-Normal
R = n-octyl

DGA-Branched
R = 2-ethylhexyl

LN's

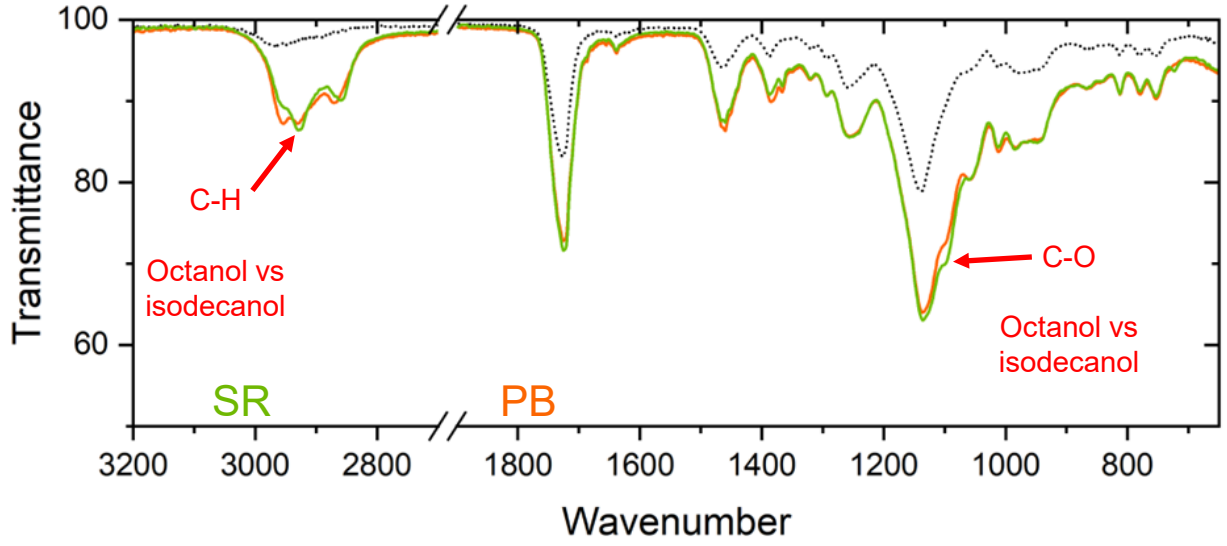
- LN series
  - Lanthanides, Y, and Sc
  - Acidic organophosphorus extractants
  - Cation exchange mechanism of extraction
  - Stark pH dependence
  - Highest adjacent Ln separation factors of all Eichrom resins
  - Dw of metal ions decrease from LN > LN2 >> LN3
  - Can act as neutral solvating or week base anion exchanges at increasing acidities

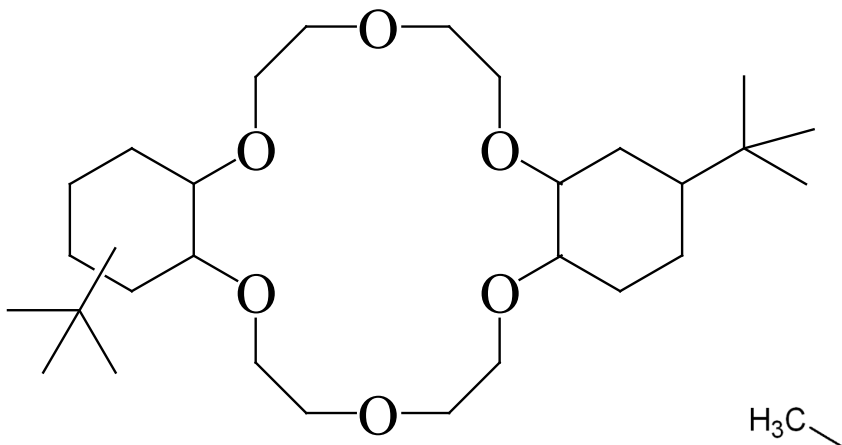




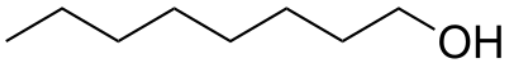
Crown Resins (SR and PB)

- SR
  - Our crown ether exists in 40 isomers!
    - Ratios of isomers impact uptake
    - Eichrom targets the same uptake (Dw = 127 for Sr from 3 M HNO3) per batch SR
  - Very high Dw for Pb
    - Difficult to recover without complexant
  - No uptake of common ions Ca^{2+} and Na^{+}
- PB
  - Lower [crown] than SR
  - Longer chain alcohol than SR
  - Lowers Dw of Pb to allows for easier recovery

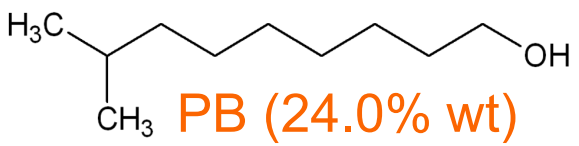




SR (20.5% wt) and
PB (16.0% wt)



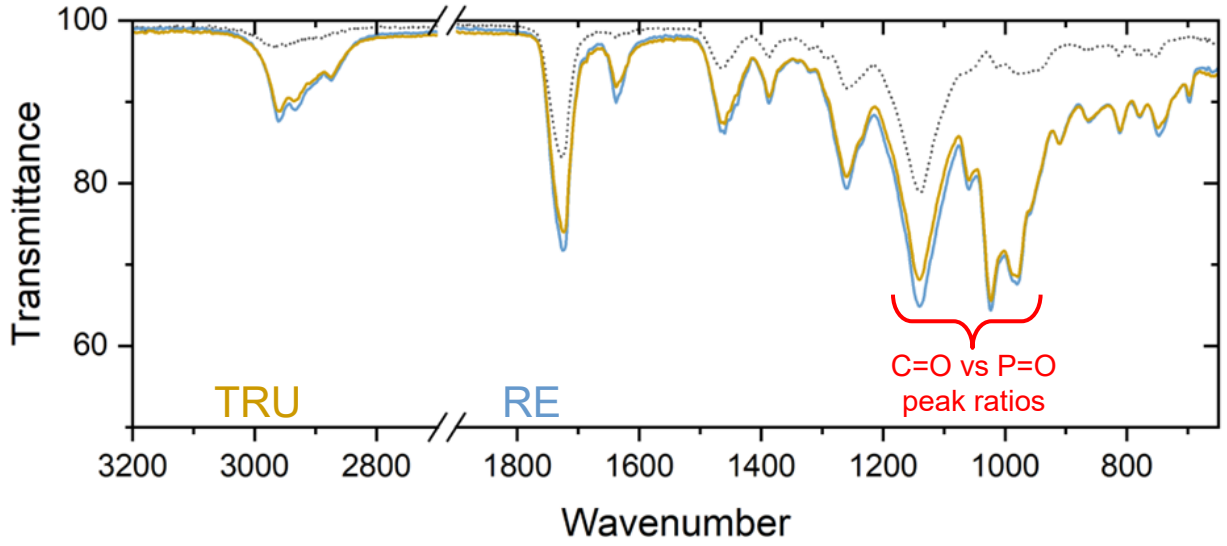
SR (18.0% wt)

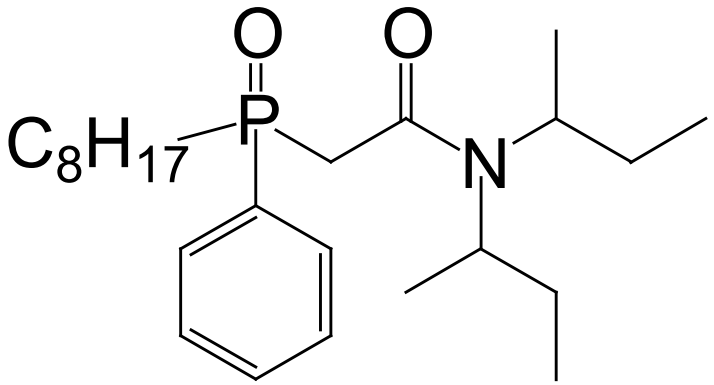


PB (24.0% wt)

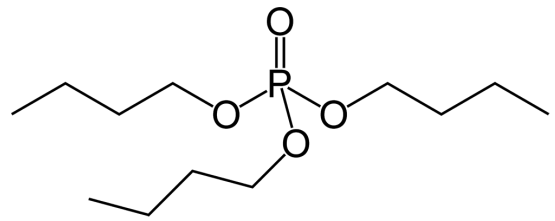
CMPO Resins (TRU and RE)

- TRU
  - Fe, Th, Pa, U, Np, Pu, Am, Cm
  - Of the transition metals, only Fe^{3+} and Zr^{4+} extracted
- RE
  - Th, U, Np, Pu, Am, Cm, Ln's, Y, and Sc
  - Group separation of rare earth elements
  - Higher CMPO concentration
  - Increased Dw
    - Especially for Ln's and Y





TRU (12.6% wt) and
RE (16.8% wt)

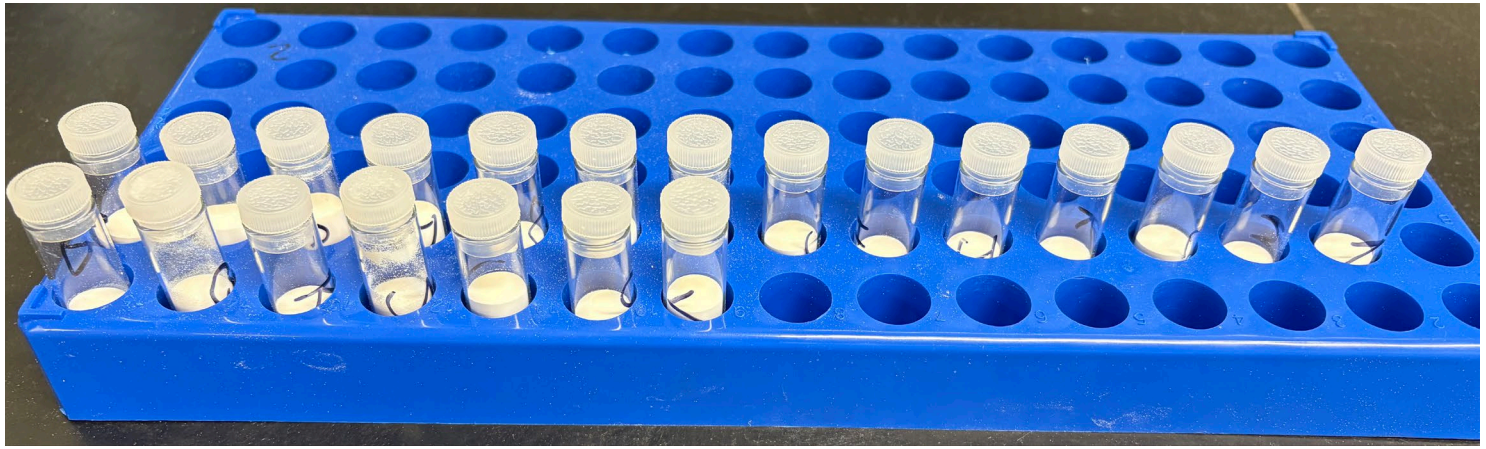


TRU (27.4% wt) and
RE (23.2% wt)

QC Analyst Blind ID Test

Procedure:

- MAE prepared 22 resin samples in shell vials labeled A-V
  - Included duplicate samples, blended resins, and non-inventory resins
- MAE provided JAM with samples and asked him to ID the resin
- JAM used the new FTIR Eichrom resins database to measure spectra
  - Combined software fit suggestions with his own judgement to ID the samples



Sample	First Match	Match Fit	Second	Third	Do you agree with the first match?	If not what resin do you think it is?
A	NORMAL	BRANCHED	DODDA	BRANCHED	NO	3
B	LN2	~~DIPEX~~ CNX	UTEVA	NE	YES	—
C	AMB	AMO	TEVA	ZR	YES	—
D	Pb	Sr	Sr	TEVA	NO	2
E	TRU	TRU	LN	NE	YES	—
F	TEVA	TEVA	WBEC	CI	YES	—
G	DODDA	DODDA	NORMAL	BRANCHED	YES	—
H	Pb	DODDA	Sr	DODDA	NO	3
I	TRU	NE	NE	UTEVA	NO	2
J	TRU	TRU	NE	UTEVA	YES	—
K	UTEVA	ACTINIDE	LN	LN2	NO	ACTINIDE
L	Pb	Sr	Sr	TEVA	NO	2
M	UTEVA	UTEVA	NE	TRU	YES	—
N	TEVA	WBEC	WBEC	CI	NO	2
O	LN	LN	TRU	UTEVA	YES	~~Pb~~
P	336 EXT.	CMPO	1-OCTANOL	DODECANOL	NO	CMPO
Q	〃	CMPO	〃	〃	NO	CMPO
R	DODDA	DGA-N	DGA-N	TEVA	NO	2
S	NI	NI	TEVA	Cu	YES	—
T	TEVA	TEVA	CI	WBEC	YES	—
U	Pb	Pb	Sr	TEVA	YES	—
V	LN3	LN3	TEVA	CI	YES	—

SAME? MISTAKE BY ME?

QC Analyst Blind ID Test

Sample	Resin	Resin Fit	First Fit	Second Fit	Third Fit	QC Resin ID
C	**Amberchrom**	0.92292	**Amberchrom**	TEVA	ZR	**Amberchrom**
F	**TEVA**	0.87270	**TEVA**	WBEC	CL	**TEVA**
M	**UTEVA**	0.88755	**UTEVA**	RE	TRU	**UTEVA**
K	**AC**	0.90213	UTEVA	LN	LN2	**AC**
O	**LN**	0.94367	**LN**	TRU	UTEVA	**LN**
B	**LN2**	0.93417	**LN2**	UTEVA	RE	**LN2**
V	**LN3**	0.90316	**LN3**	TEVA	CL	**LN3**
R	**DNS**	0.85212	DOODA	**DNS**	TEVA	**DNS**
A	**DBS**	0.84132	DNS	DOODA	**DBS**	**DBS**
G	**DOODA**	0.85303	**DOODA**	DNS	DBS	**DOODA**
D	**SR**	0.88180	PB	**SR**	TEVA	**SR**
U	**PB**	0.89244	**PB**	SR	TEVA	**PB**
J	**TRU**	0.87032	**TRU**	RE	UTEVA	**TRU**
H	**RE**	0.85859	TRU	**RE**	UTEVA	**RE**

Conclusions and Future Work

Conclusions

- FTIR spectra of Eichrom resins represent the Amberchrom support + extractant + diluent
- FTIR spectra are unique for each resin
  - Similar formulations, especially TRU/RE are nearly identical
- FTIR library can be used to ID resin
  - When used alone it is not always right
  - When coupled with personal judgement the correct resin was ID'd every time

Future Work

- Improve quality of FTIR spectrum collection parameters to increase spectral quality
- Partner with Agilent to publish spectra / library
- Use FTIR to probe SR resin shelf-life
- Use FTIR to analyze irradiated resin samples
  - Identify extent of degradation
  - Identify molecular species produced because of extractant degradation

Questions?