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The use of Deep Eutectic Solvents and Ionic Liquids in TARANTULA

Dr. Javier Nieto Maestre

javier. nieto@tecnalia.com

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The TARANTULA project

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Recovery of Tungsten, Niobium and Tantalum ocurring as by-products in mining and processing waste streams

Grant agreement ID: 821159

Ongoing

1 June 2019 – 31 Nov 2023 (54 M)

6.9 MEUR

Coordinator: TECNALIA (Spain)

Consortium: 16 partners covering the whole value chain

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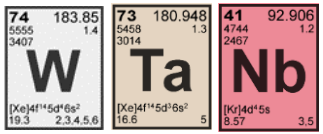
The problem

❑ Why W, Ta and Nb?

➢ Critical Raw Materials

for their increasing applications



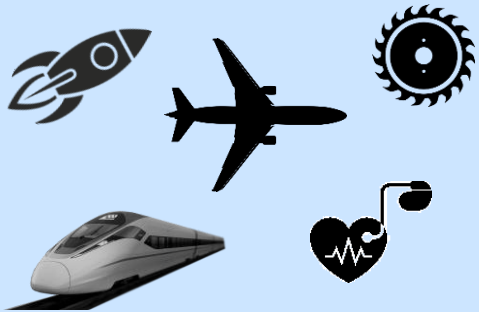
	Tungsten	Tantalum	Niobium
Melting poing (°C)	3422	3017	2477
Hardness, Brinell (HB)	294	45	75
Tensile Strength @ 1000 °C (psi)	34,500	19,000	11,000
Resistivity (nΩ · m)	52.8	131	152

Excellent mechanical and physical properties

- ❖ High melting points
- ❖ High hardness
- ❖ High tensile strength
- ❖ High conductivity

- ✓ High performance alloys
- ✓ Superconducting magnets
- ✓ Capacitors
- ✓ High temperature applications

W, Ta, Nb used in high-tech strategic technologies



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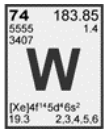
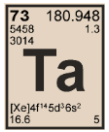
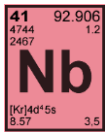
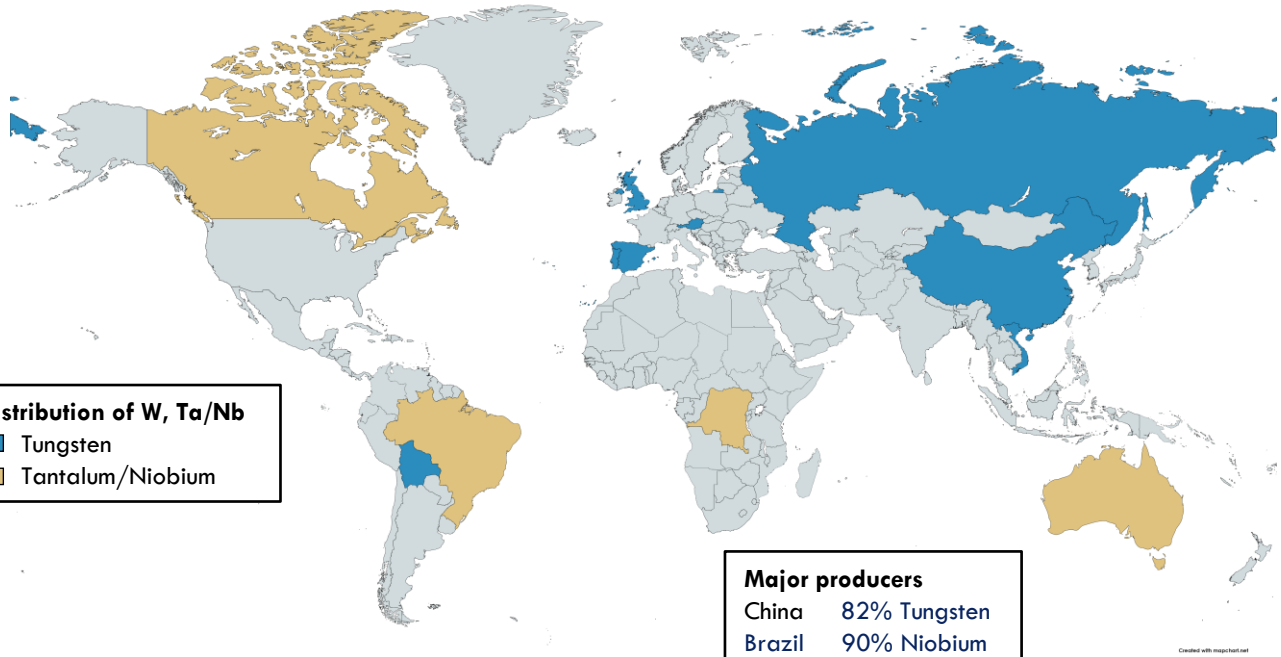
The problem

- **Why W, Ta and Nb?**
  - Critical Raw Materials
    for their scarcity in EU









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Aim of the project

To develop a suite of novel, efficient and flexible metallurgical technologies with high selectivity and recovery rates with respect to W, Nb and Ta

To reduce the dependence from non-EU countries

How?

Valorization of unconventional European resources

- Waste from tungsten mining (>0.1-0.3% WO_3)
- Mining & smelting residues from tin (Sn) primary production (>1-10% Ta_2O_5)
- Process residues from the carbide cycle

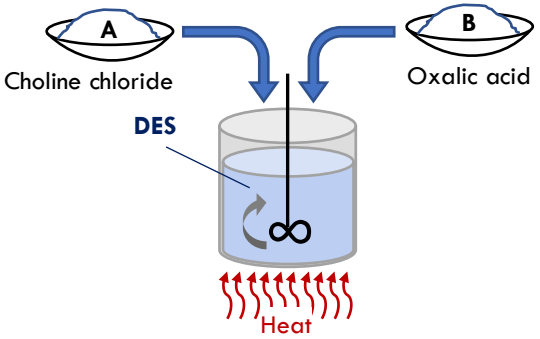
W dumps at Salau mine
~ 1 Mt 0.02% WO_3

DES and ILs for W, Ta/Nb leaching and extraction

❑ Definitions

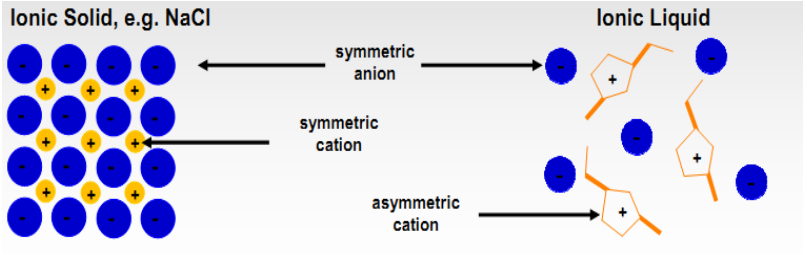
DEEP EUTECTIC SOLVENT (DES)

Systems formed from a eutectic mixture of Lewis or Brønsted acids and bases. They are classified as types of ionic solvents with special properties: eutectic with a melting point much lower than either of the individual components.



IONIC LIQUID (IL)

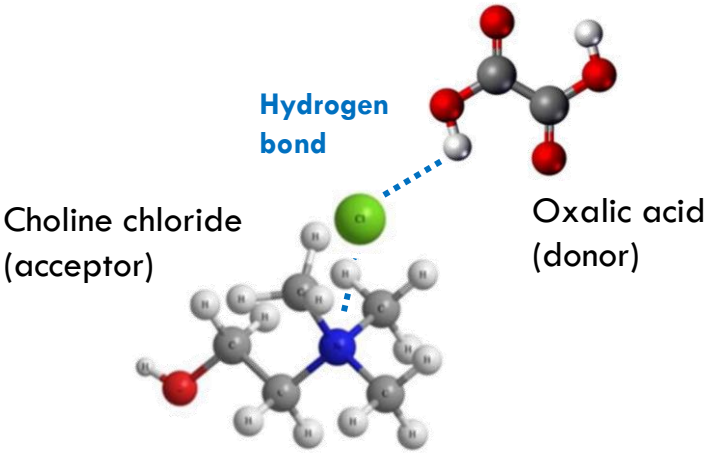
Compounds completely composed of ions with melting point below 100 °C, or even at room temperature.



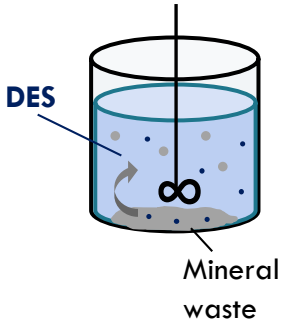
DES and ILs for W, Ta/Nb leaching and extraction

❑ DES for leaching

DES structure



DES leaching



contains

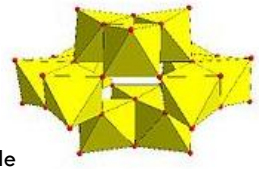
- ❖ Scheelite $CaWO_4$
- ❖ Columbite-tantalite $(Fe,Mn)(Nb,Ta)_2O_6$*

* The atomic ratio of elements (Ta, Nb, Fe, Mn) may be different

W and Ta/Nb are stabilized in DES as polyoxometallates*

- ❖ WO_4^{2-} , $H_2W_{12}O_{42}^{10-}$
- ❖ $M_6O_{18}^{8-}$ (M = Nb,Ta)

* Polyoxometallates formulas used as example



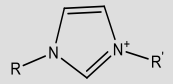
$H_2W_{12}O_{42}^{10-}$

DES and ILs for W, Ta/Nb leaching and extraction

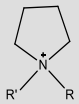
❑ ILs for L-L extraction

Discrete ion type ionic liquid

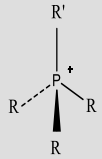
Common Cations



1,3-dialkylimidazolium

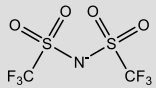


N,N-dialkylpyrrolidinium

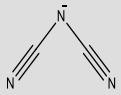


Tetraalkylphosphonium

Common anions

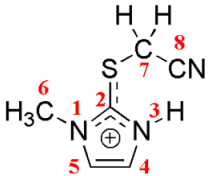


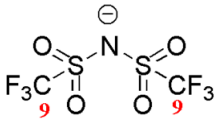
Bis(trifluoromethylsulfonyl)imide



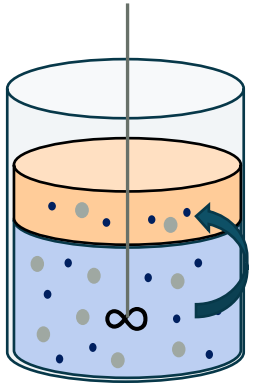
Dicyanamide

Tetrafluoroborate



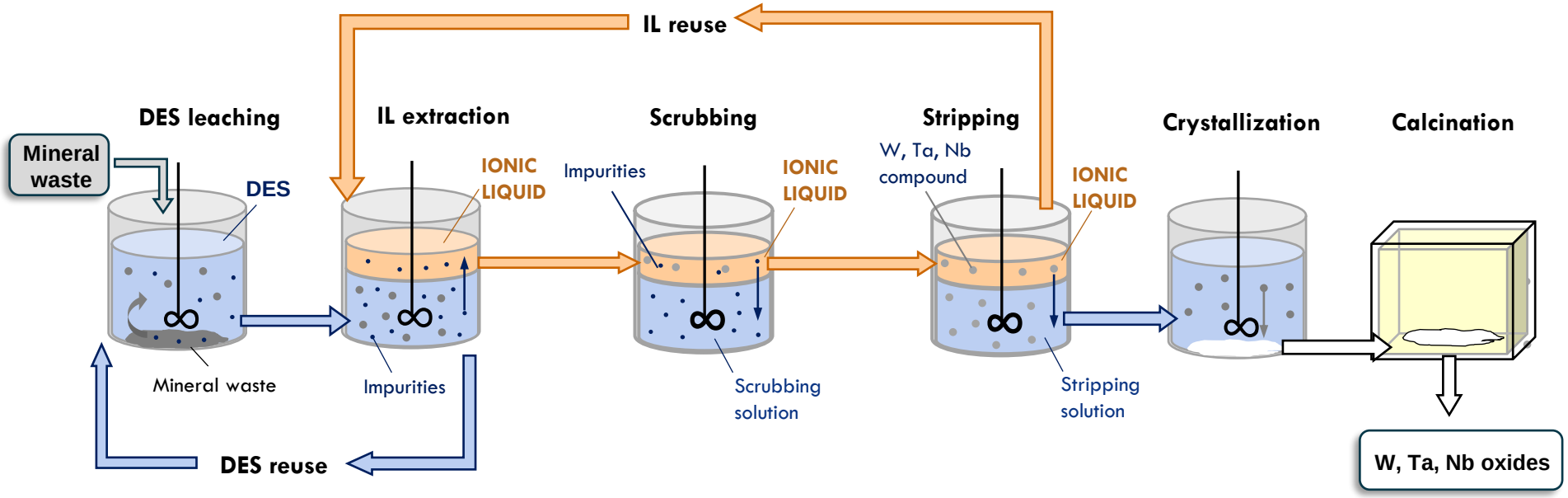


IL extraction



- Polyoxometallates are stabilized in the IL by the IL cation
- IL extraction is not selective:
  - Scrubbing and Stripping steps are needed to remove impurities and recover W or Ta/Nb

A flow-sheet for the recovery of W, Ta/Nb



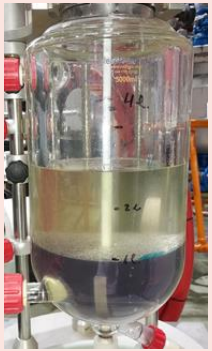
Metallic W, Ta and Nb can be produced by electrodeposition from W, Ta and Nb oxides

Main goals achieved

Global process W yield ~ 80%

Medium grade concentrate
3.4% W

Leaching



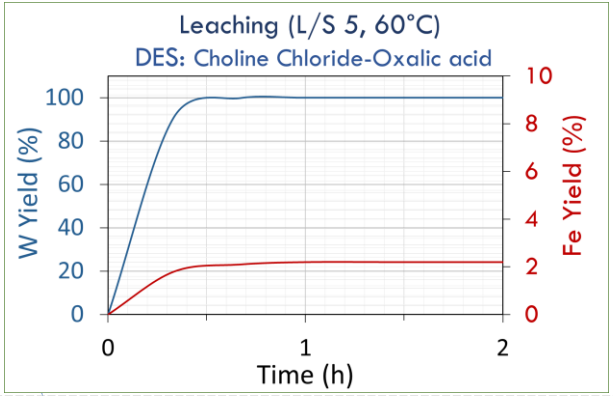
IL extraction

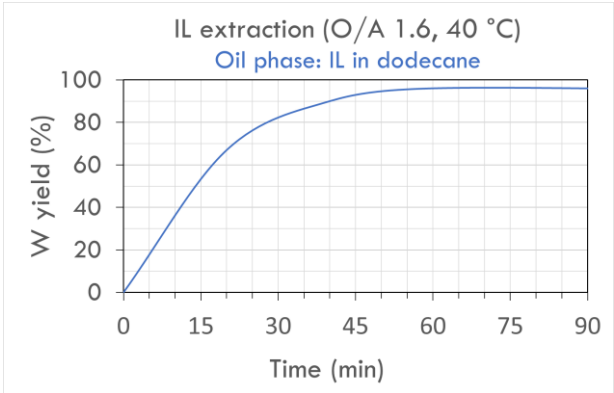
Stripping

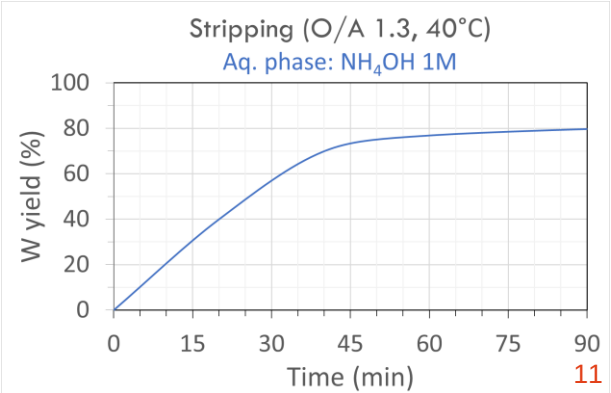
Crystallization + Calcination

Tungsten oxide
76% W

- Fe was practically not extracted in IL extraction and stripping step
- DES and IL were reused with the same W yields.







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Thank you for your attention

javier.nieto@tecnalia.com

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