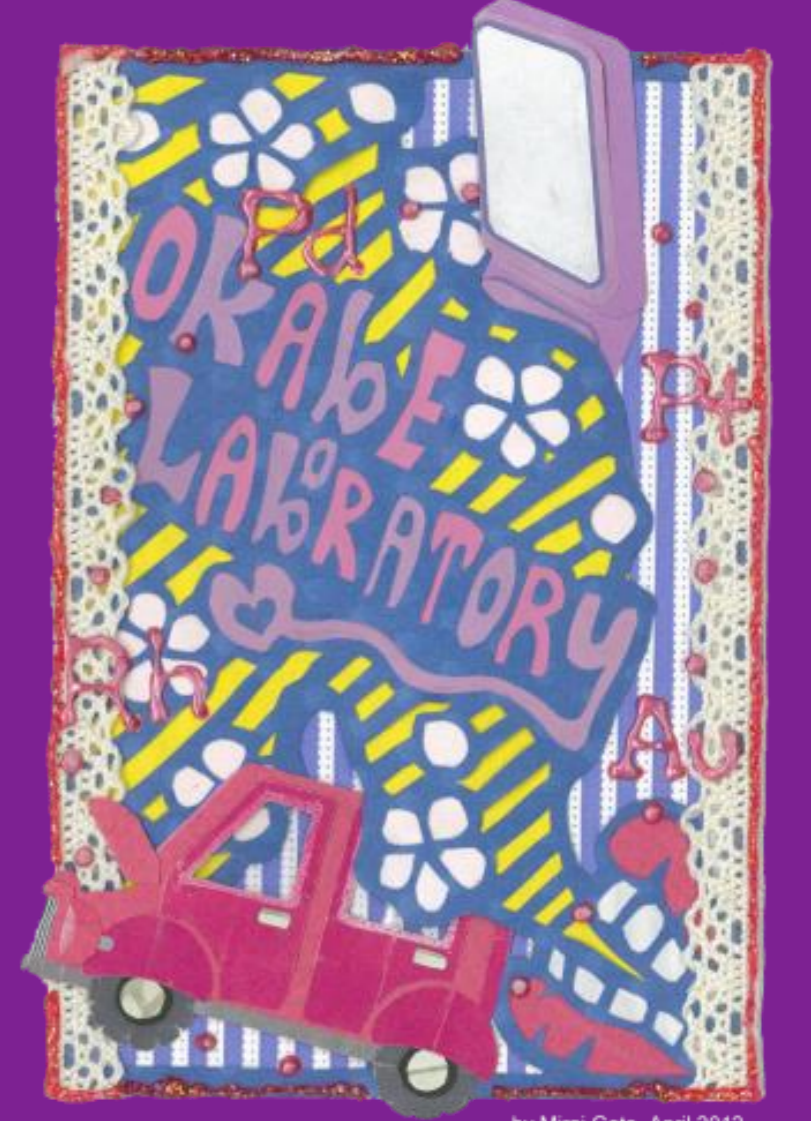


OKABE LAB.

[Future Materials : Titanium, Rare Metals]



International Research Center for Sustainable Energy and Materials

<http://okabe.iis.u-tokyo.ac.jp>

Resource Recovery and Materials Process Engineering

Department of Materials Engineering

Changing Rare Metals to “Common” Metals !

Okabe Lab. is focusing on research into new production processes for reactive metals and environmentally sound recycling technologies for rare metals, based on “Future Materials : Titanium, Rare Metals” as the keywords.

We believe that we can contribute to the society by developing innovative process technologies for rare metals.

Environmentally Sound Recycling Process for Rare Metals

Titanium (Ti):

Excellent mechanical property
Abundant mineral resource

Aerospace
→High strength and lightweight materials
About 14 wt% of a Boeing 787 consists of Ti.

Marine Structures
→Corrosion-resistant materials
1000 t of Ti was used for the D runway of Haneda Airport.

Recycling technologies for low-grade Ti metal scraps utilizing molten-salt-based reactions

Cut chips



Fabrication of aviation parts using Ti alloys usually involve a material loss of up to 80-90%.

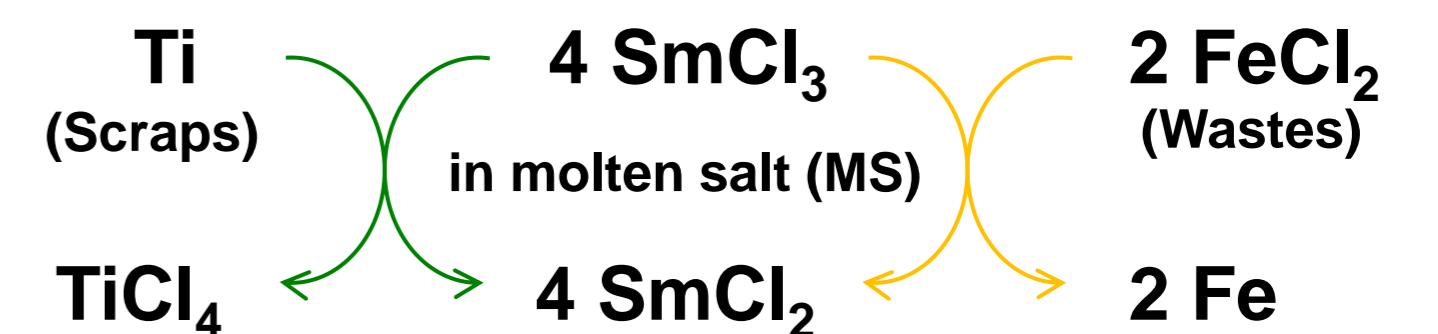
O and Fe removal from Ti is very difficult.

“Electrochemical deoxidation”

Oxygen dissolved in scrap was removed by electrolysis in MgCl₂.

“Reaction-mediator-based chlorination”

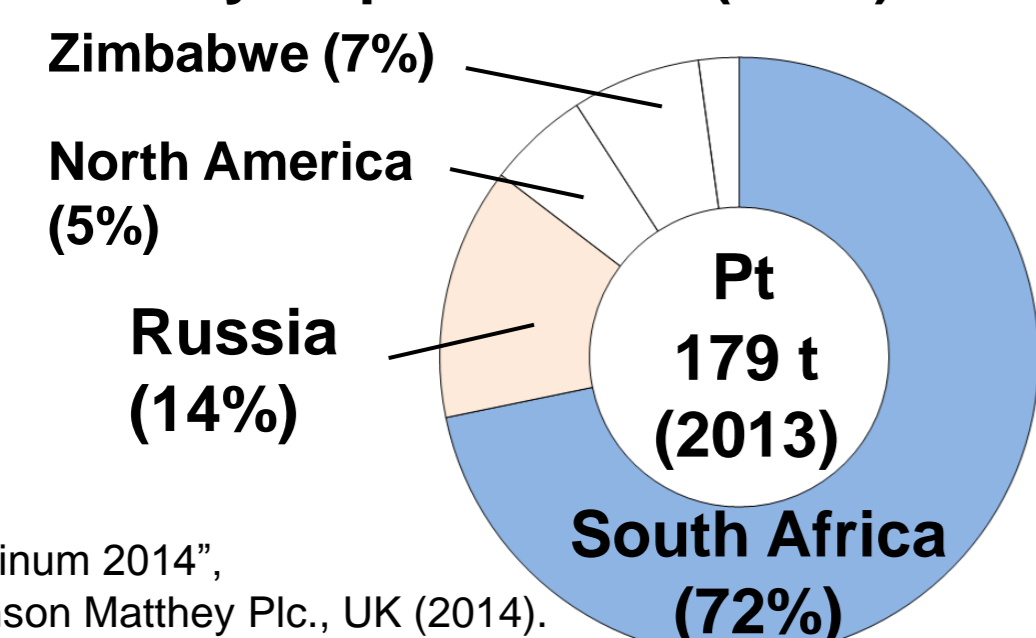
TiCl₄ was effectively recovered by combining Ti scrap and chloride waste.



Platinum Group Metals (PGMs):

Expensive
Uneven distribution

Primary Pt production (2013)

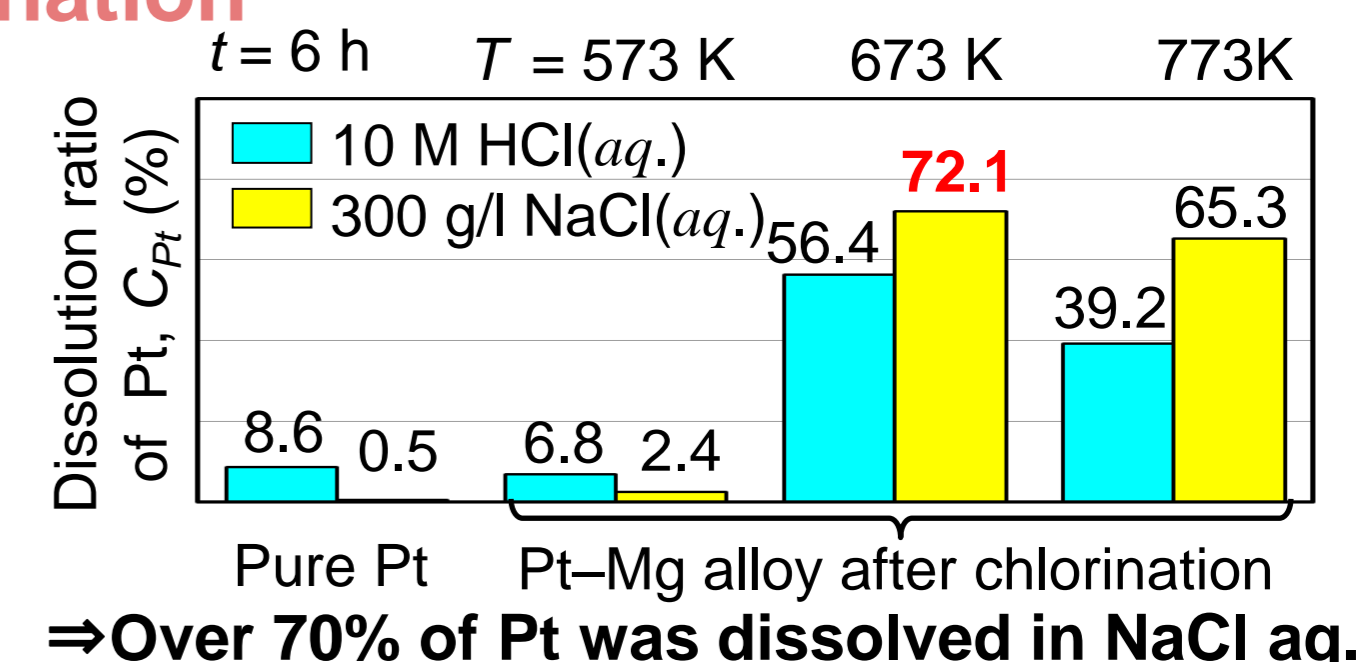
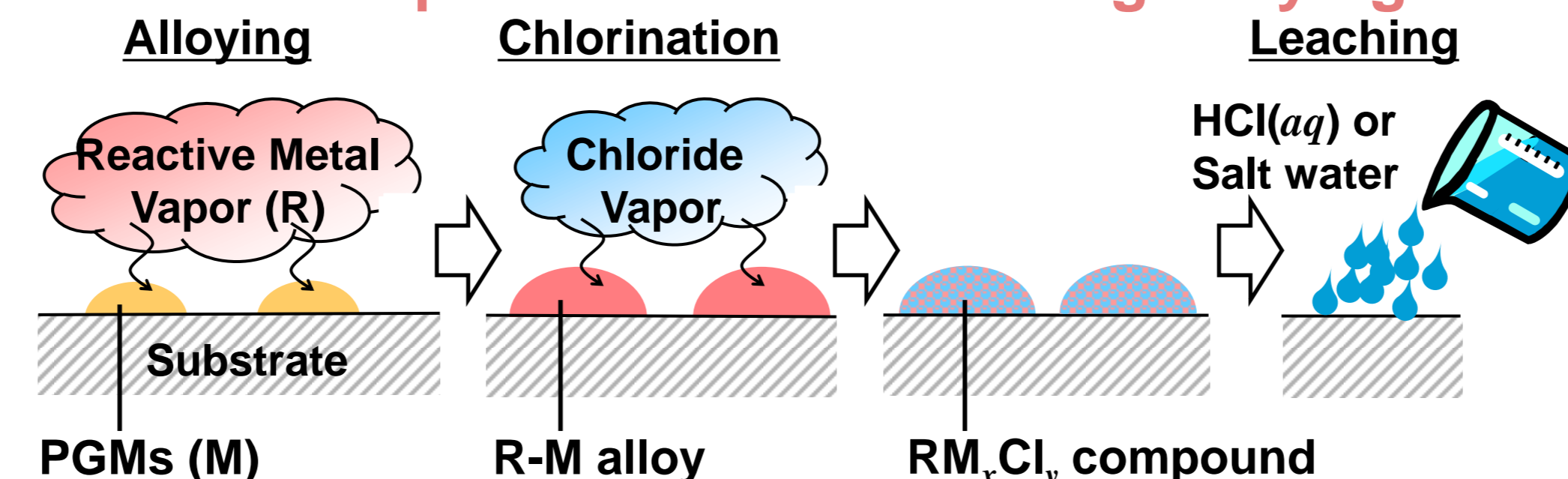


“Platinum 2014”, Johnson Matthey Plc., UK (2014).



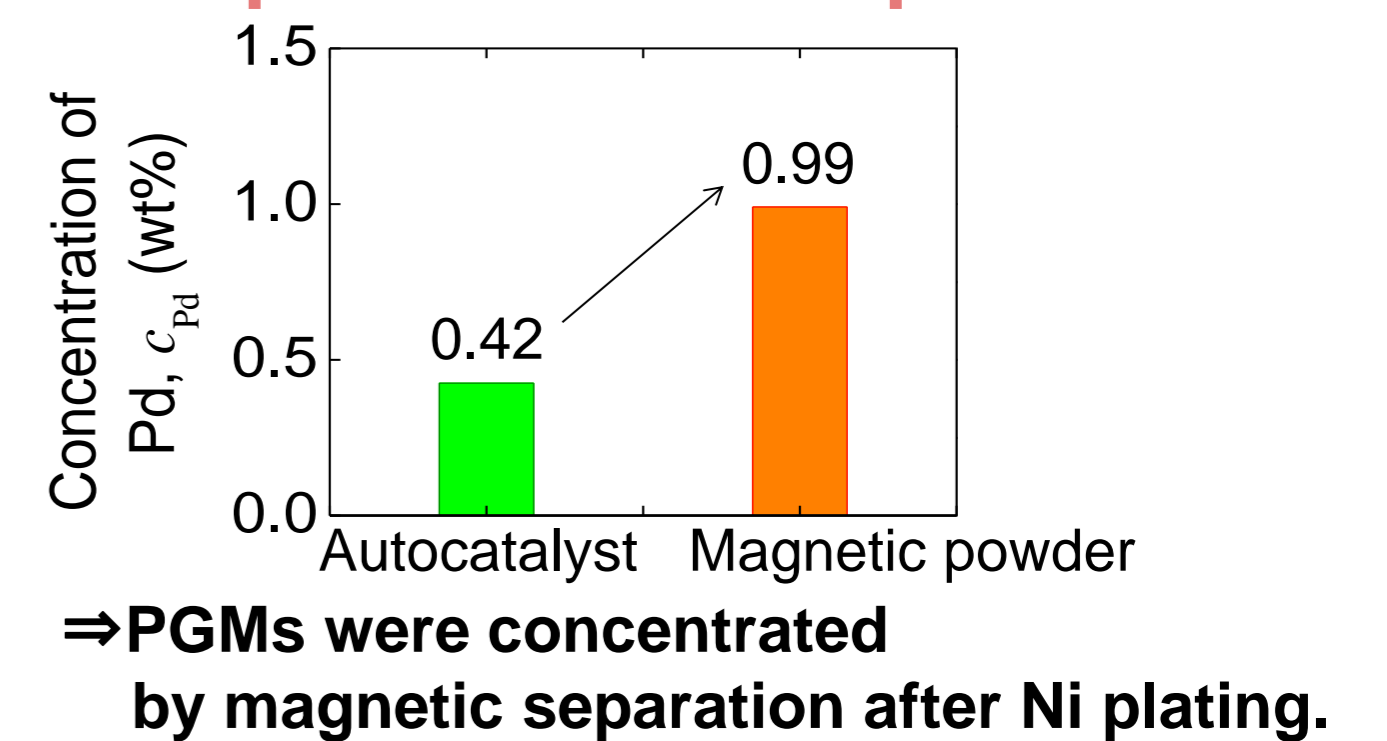
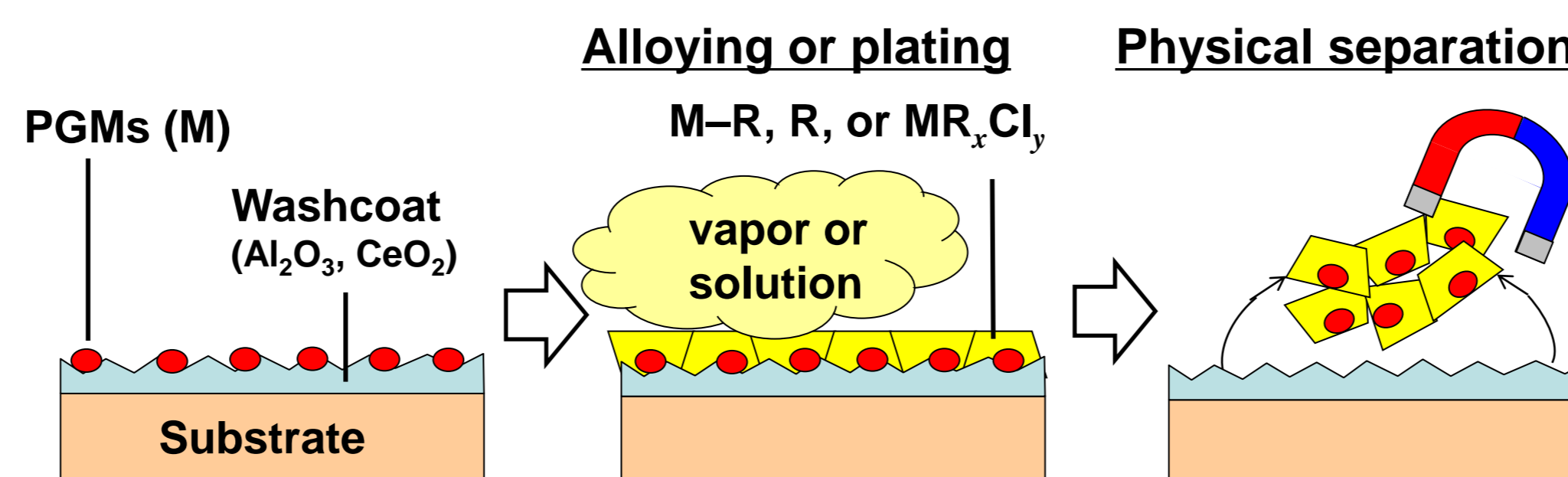
Major demand for Platinum (Pt), Palladium (Pd), Rhodium (Rh).

Dissolution process for PGMs using alloying and chlorination



⇒ Over 70% of Pt was dissolved in NaCl aq.

Condensation process for PGMs in scraps utilizing physical separation technique



⇒ PGMs were concentrated by magnetic separation after Ni plating.

Refractory metals such as Tungsten (W) and Rhenium (Re)

Main W application: Cemented carbide tools



Supply of W resource is highly localized in China just like rare earth elements.

Main Re application: Turbine blade

Re-added Ni-based superalloy is used

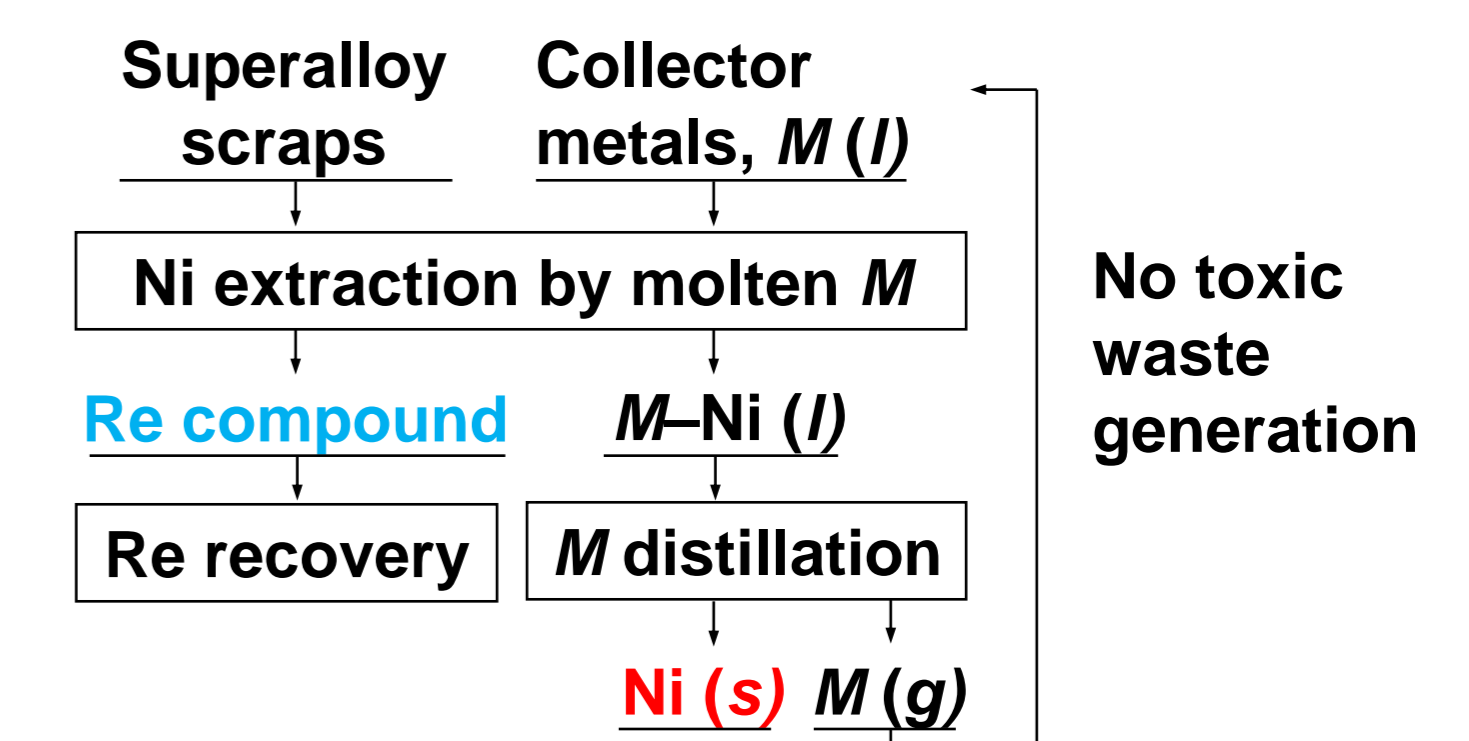


Re is one of the rarest elements in the world

Environmentally sound recycling without toxic waste generation has been investigated.

- Metal extraction using low-melting metal as a collector
- Separation and refining of rare metals based on chloride volatilization

Recycling of superalloy utilizing collector metals



Copper (Cu):

Superior thermal and electrical conductivity

Main Cu application: Electrical and electronic products



Printed board: Cu film is used as electronic circuit

[ref] Yoshiaki Electronics Industrial Co., Ltd, webpage

Novel Cu refining technique using chlorination

Electrorefining



[Ref] <http://www2.edu-ctr.pref.okayama.jp/>

Electrochemical reaction occurs only on the surface of electrolytic cells

Many electrolytic cells are needed to compensate the low productivity of this method

Novel Cu refining technique based on chemical vapor transportation of CuCl_x is being developed.

