IRCSEM

OKABE LAB.

[Future Materials: Titanium, Rare Metals]

Integrated Research Center for Sustainable Energy and Materials

Resource Recovery and Materials Process Engineering

Department of Materials Engineering

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

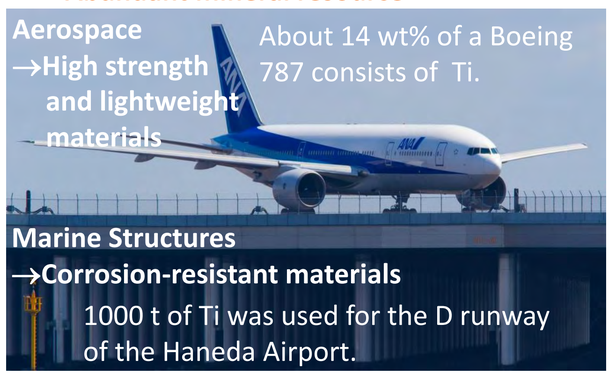
Changing Rare Metals to "Common" Metals !

The Okabe Laboratory 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

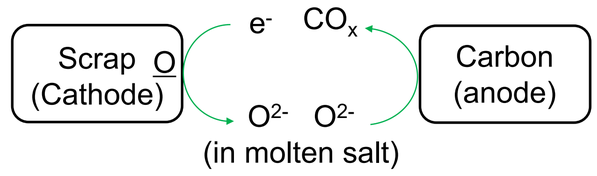


Recycling technologies for low-grade Ti metal scraps utilizing molten-salt-based reactions

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

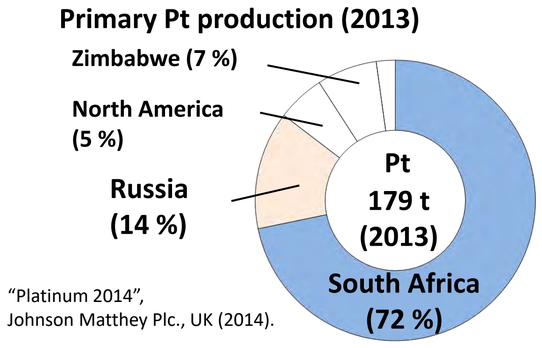
O and Fe removal from Ti is very difficult.

"Electrochemical deoxidation"
Oxygen dissolved in Ti scrap was removed by electrolysis in $MgCl_2$.
"Reaction-mediator-based chlorination"
$TiCl_4$ was effectively recovered by combining Ti scrap and chloride waste.



Platinum Group Metals (PGMs):

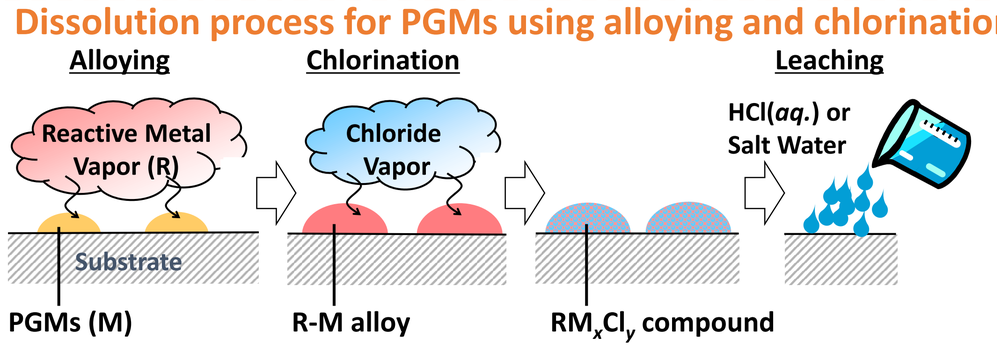
Expensive
Uneven distribution

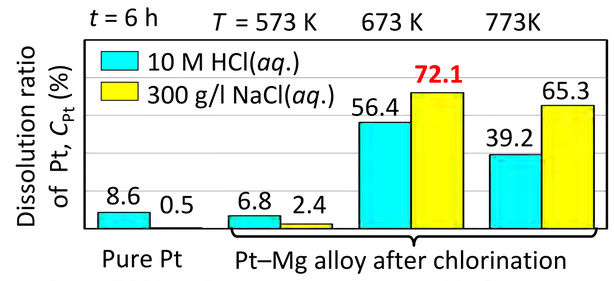


"Platinum 2014", Johnson Matthey Plc., UK (2014).

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

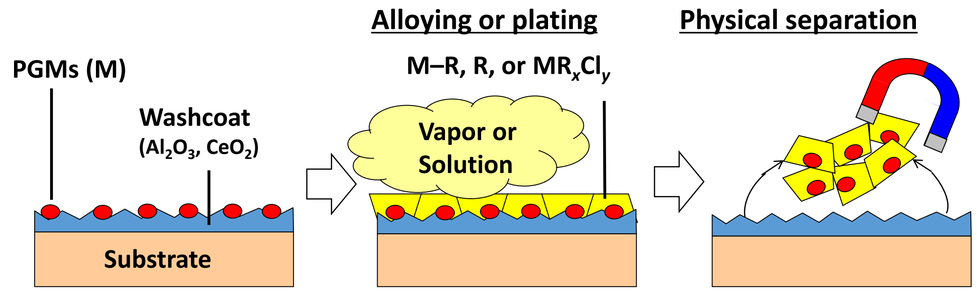
Dissolution process for PGMs using alloying and chlorination

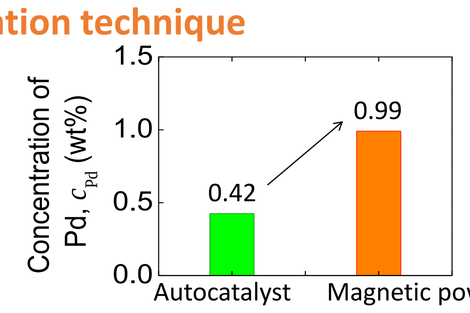




⇒Over 70% of Pt was dissolved in NaCl aq.

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.

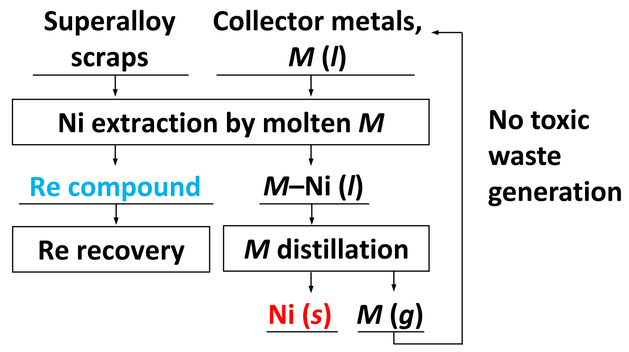
Main Re application : Turbine blade
Re-added Ni-based superalloy is used

[ref] Honda Motor Co., Ltd, webpage
Re is one of the rarest elements in the world

Environmentally sound recycling without toxic waste generation has been investigated.

- Metal extraction using a low-melting metal as collector
- Separation and refining of rare metals by using molten salts

Recycling of superalloy utilizing collector metals



Development of novel process for producing high-quality Ti products

Titanium valves in engines of motorcycles

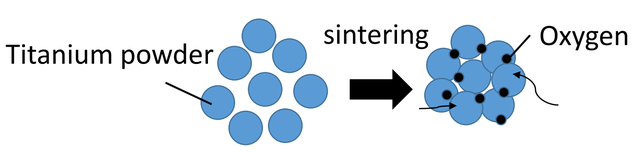
Ti products are used in aeroplanes, automobiles, motorcycles.
However, it is difficult to machine Ti.

➡ **Developing a novel process for producing high-quality Ti products by applying powder metallurgy**

http://www.bikebros.co.jp/vb/offroad/ofeat/ofeat-20130620/

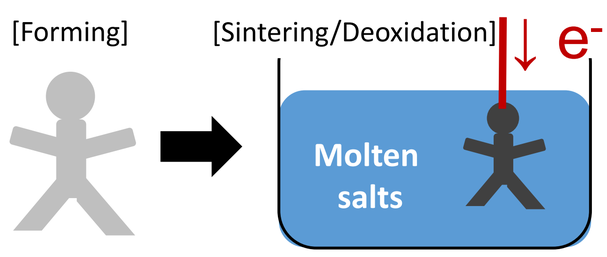
Problems of Ti powder metallurgy

- **Ti reacts with oxygen in sintering step**
- **Oxygen degrades properties of Ti**



Oxygen concentration in Ti increases during sintering due to its strong chemical affinity with Ti

Novel process for making Ti products



High-quality Ti products can be produced by sintering and deoxidation in molten salt