

# OKABE LAB.

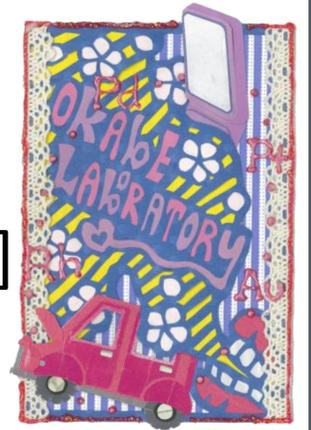
## [Future Materials: Titanium, Rare Metals]

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

**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 the 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 involves a material loss of up to 80-90%.

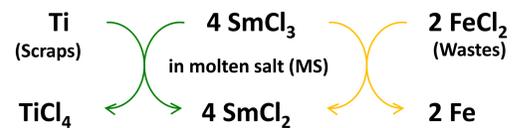
O and Fe removal from Ti is very difficult.

#### “Electrochemical deoxidation”

Oxygen dissolved in Ti scrap was removed by electrolysis in MgCl<sub>2</sub>.

#### “Reaction-mediator-based chlorination”

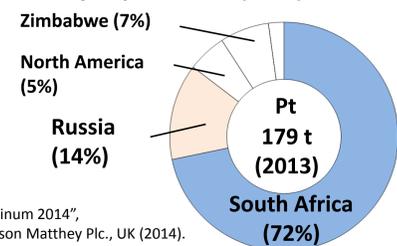
TiCl<sub>4</sub> was effectively recovered by combining Ti scrap and chloride waste.



#### Platinum Group Metals (PGMs):

Expensive  
Uneven distribution

#### Primary Pt production (2013)

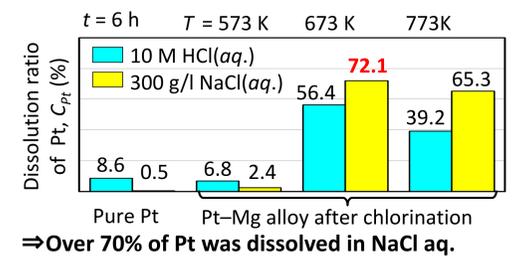
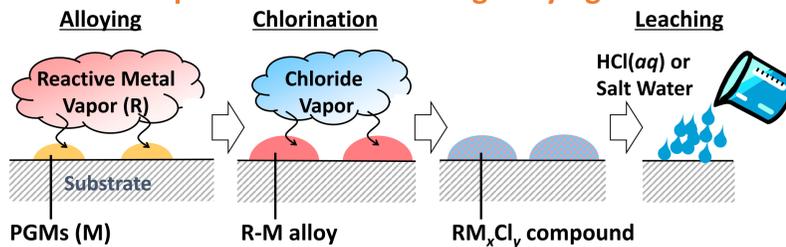


“Platinum 2014”, Johnson Matthey Plc., UK (2014).



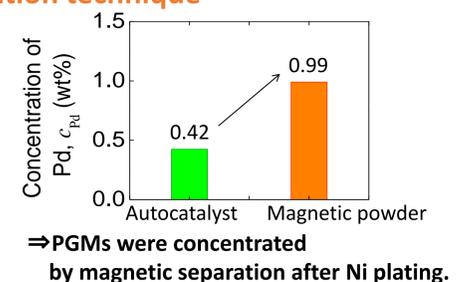
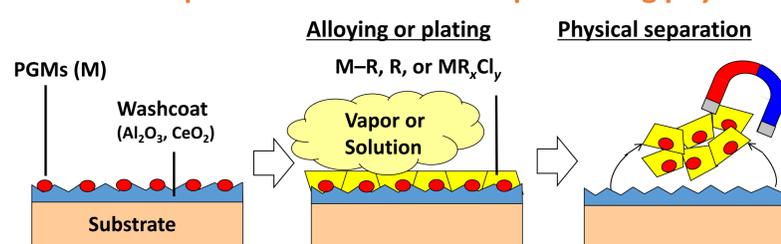
Major demand for Platinum (Pt), Palladium (Pd), Rhodium (Rh).

#### 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

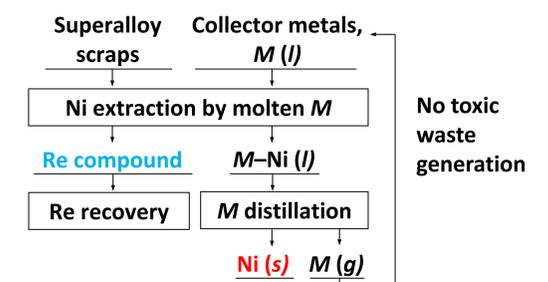


Re is one of the rarest elements in the world

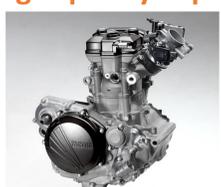
Environmentally sound recycling without toxic waste generation has been investigated.

- Metal extraction using 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/>

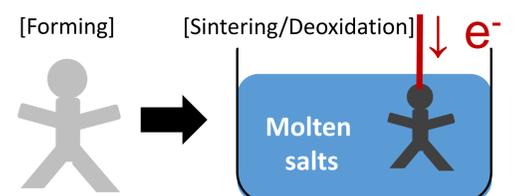
#### Problems of Ti powder metallurgy

- 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