Fw-302



OKABE LAB.

[Future Materials : Titanium, Rare Metals]

International Research Center for Sustainable Materials

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Rare-Metal Process Engineering

Department of Materials Engineering

Changing Rare Metals into "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 we can contribute to society by developing innovative process technologies for rare metals.

New Production Process for Rare Metals

New Production Process for Titanium Ti has a high strength-to-density ratio, Upgrading of titanium ore corrosion resistance, and abundant through selective chlorination using metal chlorides mineral resources. so "base metal in the near future". Concentration of element i, Ci (mass%) Metal erospace industr chloride, Atmosphere Feedstock After reaction #1 Ilmenite (FeTiO_x) HCI MCI_x Ilmenite (FeTiO_x) H₂O 15 wt% of a Boeing 787 MCl. Fe High-strength and lightweight mater Ti Ti Fe consists of Ti. CaCl 49.3 96.7 Ar 45.0 0.2 Selective chlorination #1 Selective chlorination #2 MgCl₂ 45.0 49.7 96.7 are essential. Ar 1.8 49.7 97.2 MgCl₂ $Ar + H_2O$ 45.0 1.2 H₂O TiO₂ FeCl_x FeCl, MTiO_x HCI Before Exp. After Exp Marine Structures [Chlorination #1] [Chlorination #2] Corrosion-resistant FeO(s) + 2 HCl(g) $FeO(s) + TiO_2(s) + MCl_2(l)$ erials are req = $\operatorname{FeCl}_2(l,g)$ + $\operatorname{H}_2O(g)$ = $\operatorname{FeCl}_2(l,g) + \operatorname{MTiO}_3(s)$ 1000 t of Ti was used for the D runway Iron was effectively removed from ore. of Haneda Airport (TiO₂: 51% \rightarrow about 97%) **Environmentally Sound Recycling Technology for Rare Metals** Efficient recovery process for PGMs (platinum group metals) **Recovery process for PGMs Recovery process for PGMs** Pt production in 2008 Recovery using alloying and chlorination using physical separation method (Autocatalyst Chlorination Alloying or Plating Physical separation Alloying Leaching 14.4% Others Salt water Pt-M, PtM, Cl, Chloride North PGMs (M) RM CI Pt. Pd. Rh Vapor (R) Pt America M vapor, 4.7% Washcoat MCI. 216.9 t 11.8% (Al₂O₃, CeO₂) Scrap substrate Russia R-M alloy Cordierite South Africa Maldistribution of mines 65.0% T = 573 K 673 K 773K Ę Magnetically attracted specime Ę Jollie, D. :"Platinum 2009", Johnson Matthey Plc., UK (2009). Extremely low production in ag. 10 M HCl solution Pt. t = 6 hConcentration of C_{Pt} (wt%) q ъ in aq. 300 g/l NaCl solution (%) Autocatalys HDD Residue Dissolution C_{Pt} 1.0 % 6.8 2.4 8.6 0.5 Initial model sample After magnetic separation Pure Pt Pt-Mg alloy after chlorination Ru Condensation of Pt was observed Over 70% of Pt was dissolved in NaCl aq. after magnetic separation. New recovery process for REEs (rare earth elements) from magnet scrap Extraction ratio of Nd, Dy by molten MqCl₂ REE oxide production in 2010 Recovery process for REEs using molten salt 100 India 2.2% Other 0.8% % ₈₀ Efficient recovery Restriction on exports of Ľ rocess for REEs 60 **REEs by China in 2010** Extraction ratio, Total 133 kt 40 Nd-Fe-B alloy magnets In Japan, few "natural mineral **REE compounds** Nd The resources", but abundant "artificial 20 (Oxides) Dy Flow of resources" as commercial products. present Nd and Dy 0 9 12 China -83.3 Ô 3 6 study 97% Reaction time, t / hour Recycling and stockpilling Extraction by molten salts USGS Mineral Commodity of REEs are important. Over 80% of Nd. Dv were Currently, REEs are HEVs, EVs extracted successfully. 97% of REEs were Motor scraps discarded and not recycled. produced in China.

Institute of Industrial Science