

T. H. OKABE LAB.

Future Material: Titanium



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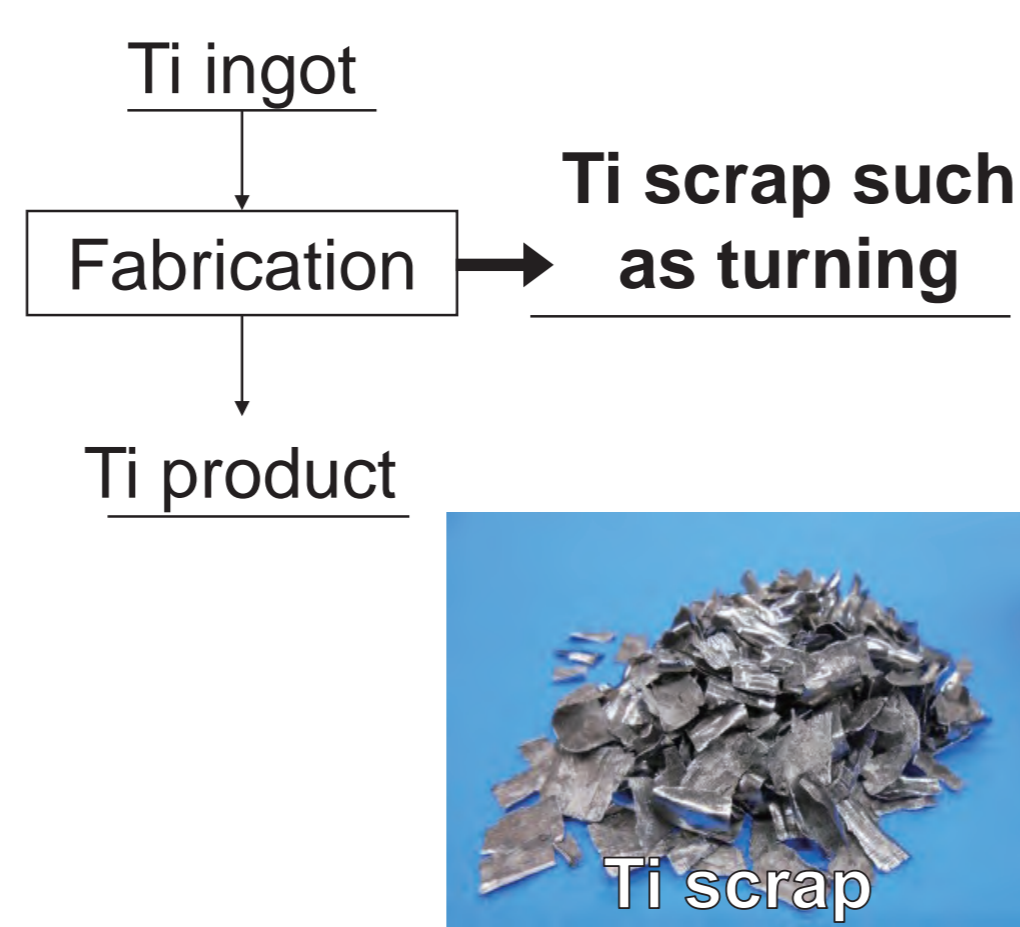
Turning titanium into a “common metal”!!

Titanium (Ti), with its abundant resources and excellent properties, is in growing demand yearly. However, its widespread adoption is hindered by the difficulty of separating titanium from oxygen in ores, preventing it from being mass-produced like iron or aluminum. Additionally, the high affinity between titanium and oxygen makes the recycling of titanium scrap difficult. Our laboratory is researching and developing rapid deoxidation technology using rare earth metals and their halides. This technology is expected to enable faster, large-scale production of Ti by integrating smelting, melting, and casting processes and to lead to an increase in the widespread use of titanium products.

Upgrade recycling of Ti

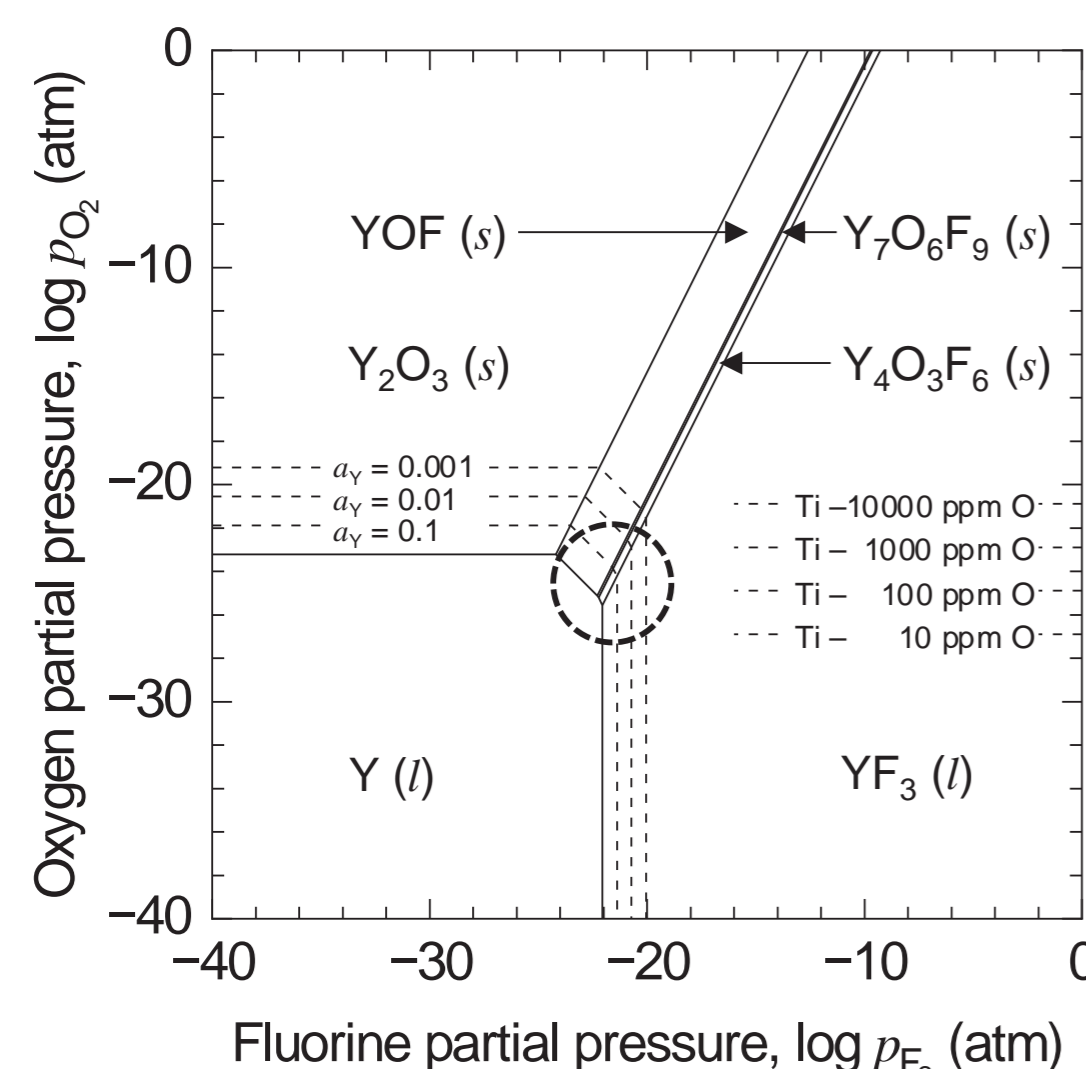
Aerospace
→ High specific strength
About 14 wt% of a Boeing 787 consists of Ti.

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

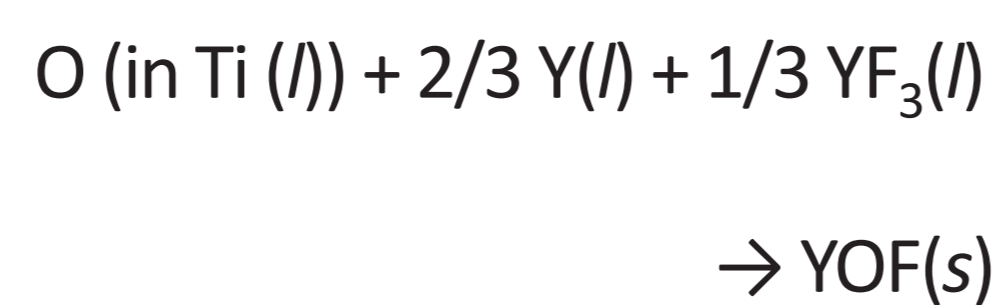


Titanium (Ti) scrap generated during the Ti ingot fabrication process is contaminated with oxygen impurities. Therefore, recycling and repurposing Ti scraps for ingot production is difficult.

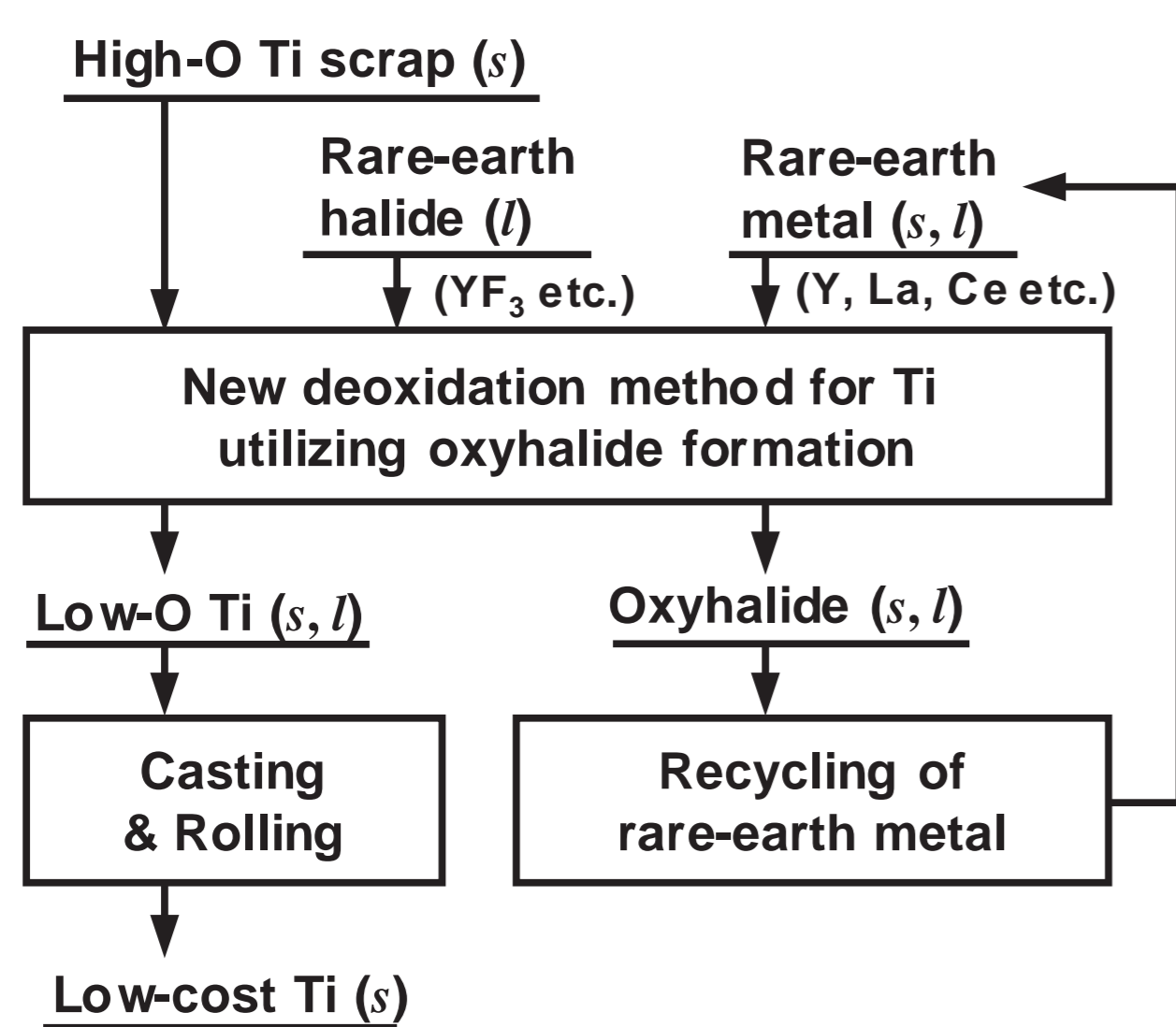
Deoxidation of Ti using rare earth metals



A thermodynamic study of deoxidation limits through oxyhalide formation reactions shows that yttrium (Y) can deoxidize molten titanium, making low-oxygen titanium production feasible. The deoxidation reaction is as follows:



Y-O-F system isothermal chemical potential diagram (2000 K)

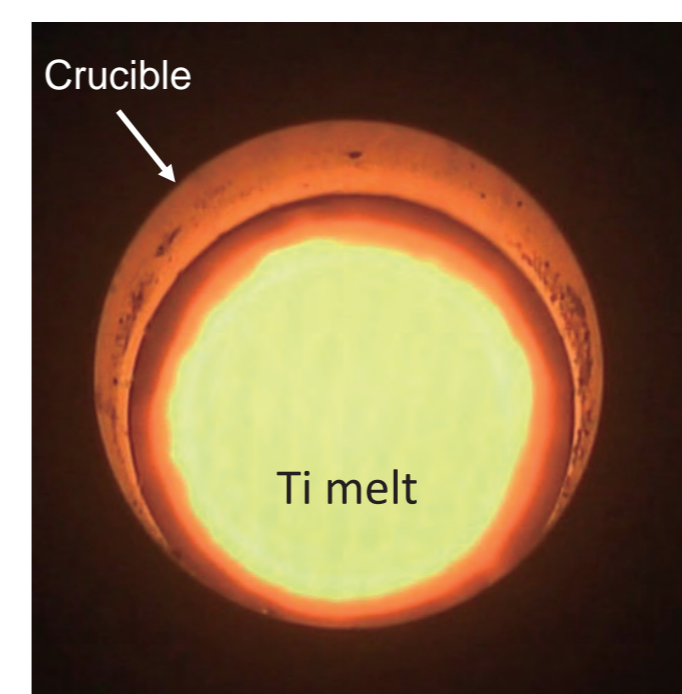


Recycling process diagram

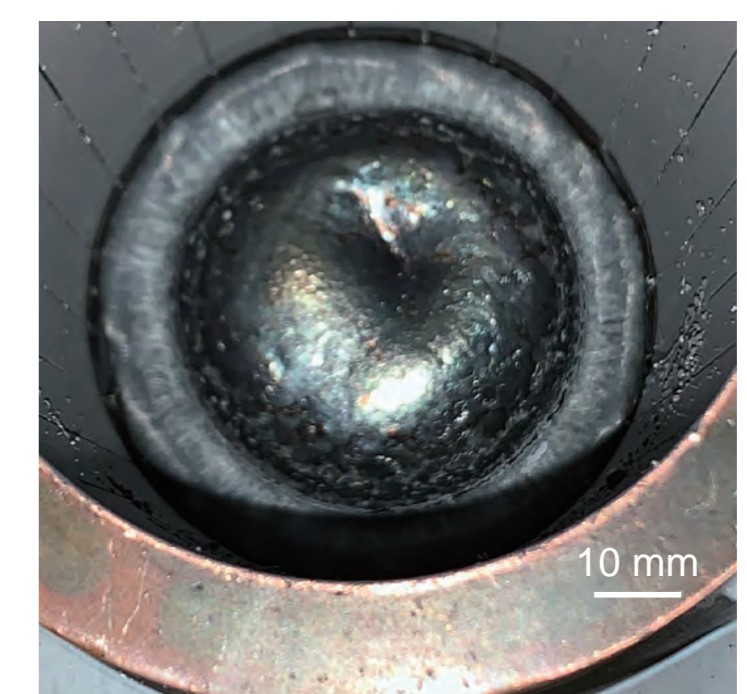
This process enables the production of low-oxygen titanium from high-oxygen titanium scrap through upgraded recycling.

Verification of rapid deoxidation from molten Ti

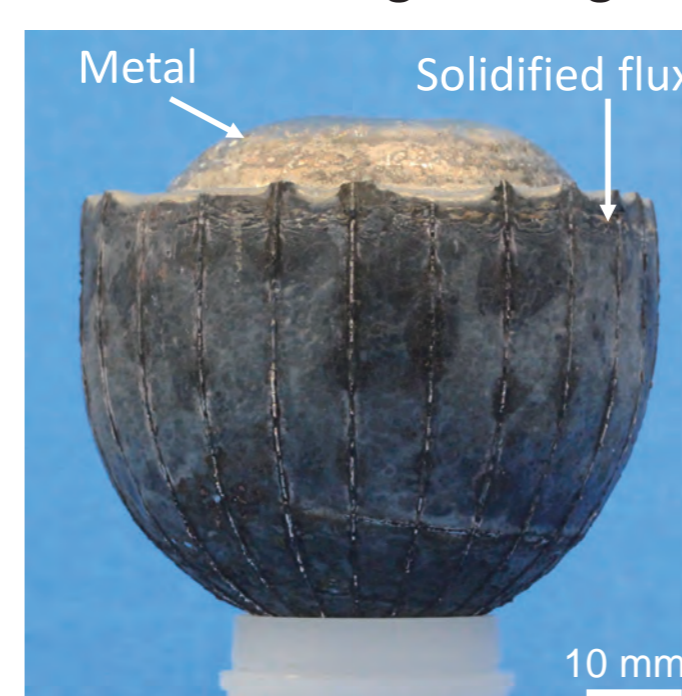
By melting Ti (1 mass% O) with Y and YF₃ for 15 minutes, titanium with a low oxygen concentration of 200 mass ppm was obtained.



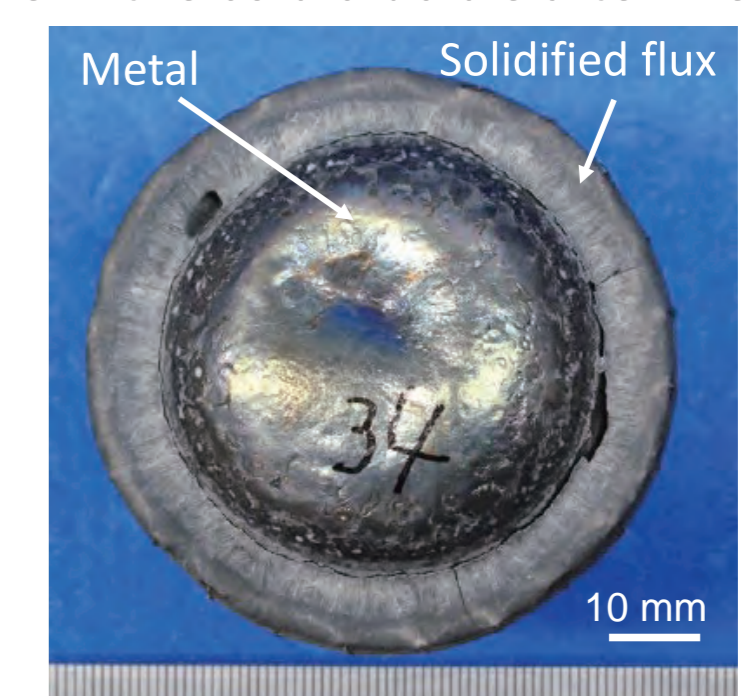
State during melting



Sample in the cold crucible after melting



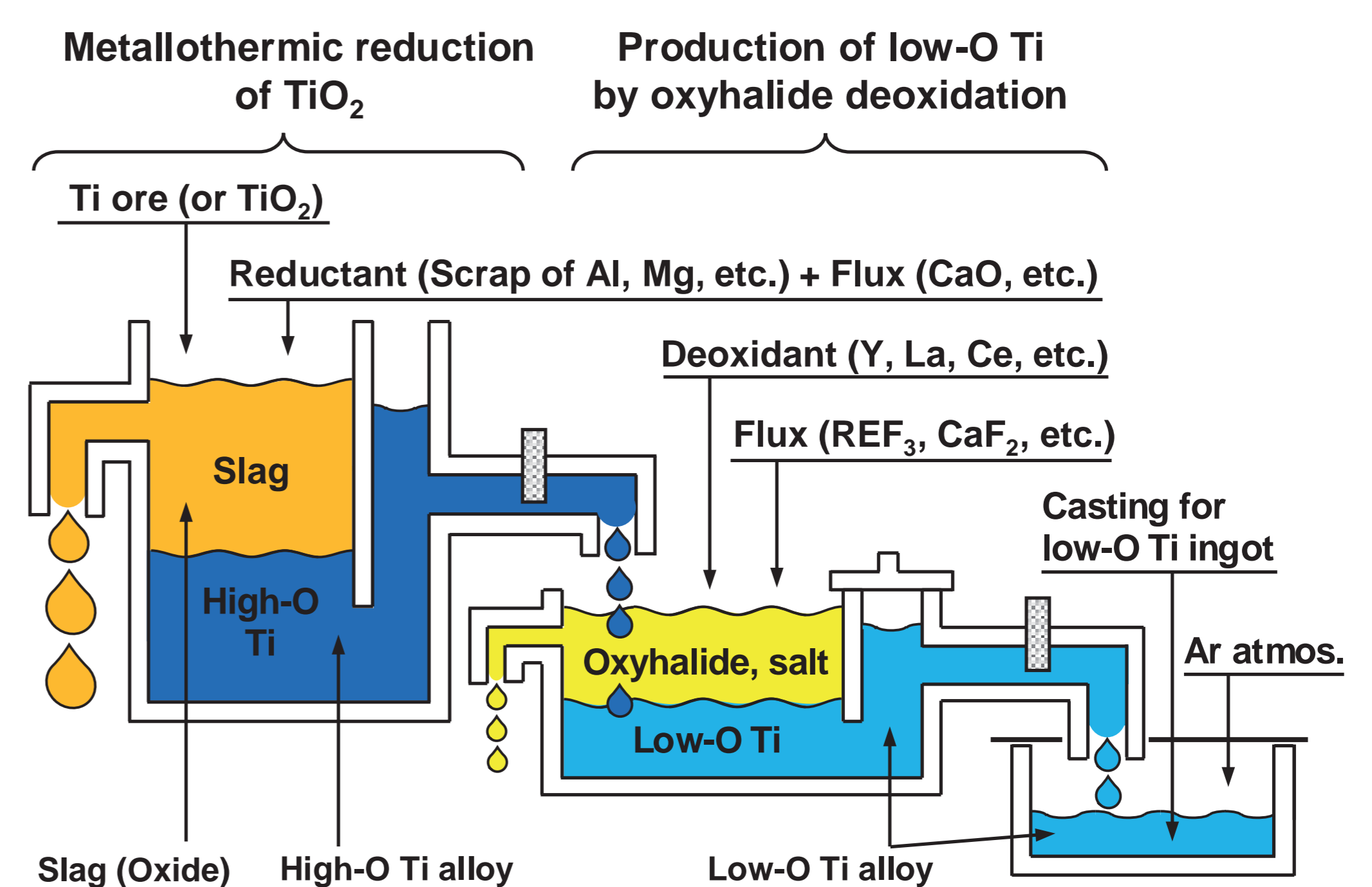
Side views of the sample



Top views of the sample

New smelting method for Ti

The proposed deoxidation technique has the potential to establish large-scale production of titanium by seamlessly integrating refining, melting, and casting processes.



Conceptual diagram : New smelting method for producing Ti or Ti alloy from TiO₂.