# Reduction of Titanium Oxide in Molten Salt Medium

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**Abstract**

In the recent years, a new titanium reduction process directly from titanium oxide ($TiO_2$) by the electrochemical reduction of $TiO_2$ in molten calcium chloride ($CaCl_2$) was investigated as an alternative process of the Kroll process [Chen *et al.*: Nature, 407 (2000) 361], and there is a large variety of titanium reduction processes currently under investigation [Ono & Suzuki: Journal of Metals, 54 Feb., (2002) 59].

In this study we explored the production of titanium powder by an electronically mediated reaction (EMR) using calcium as a reductant for titanium oxide ($TiO_2$) [Okabe & Sadoway: J. Materials Research, 13 (1998) 3372]. Feed material, $TiO_2$, and reductant calcium alloy containing nickel, *etc*. were charged into electronically isolated locations in a $CaCl_2$ molten salt at 1173 K. The flow of current through an external path between the feed and reductant locations, and electrochemical potentials of the feed electrode were monitored during the reduction experiment [Okabe *et al.*: J. Alloys and Compounds, 288 (1999) 200]. After the experiment, pure titanium powder with low nickel content was obtained although liquid Ca-Ni alloy was used as the reductant. This clearly demonstrates that titanium metal powder can be produced by electrochemical reactions, without direct physical contact between the feed ($TiO_2$) and reductant (calcium alloy). Pure titanium in sponge form with 99.5 mass% purity was obtained in some experiments. The method has the potential for preventing accumulation of impurities into titanium deposits because impurities in the molten salt can be trapped by the reductant alloy placed in the different location from the titanium reduction site. Energy efficiency of the reduction process can also be improved when combined with conventional molten salt electrolysis (MSE) of $CaCl_2$ for calcium alloy reductant production. Difference and features of various reduction processes are discussed.