Combined TiO_2-Chlorination and electrolytic $TiCl_x$-Reduction

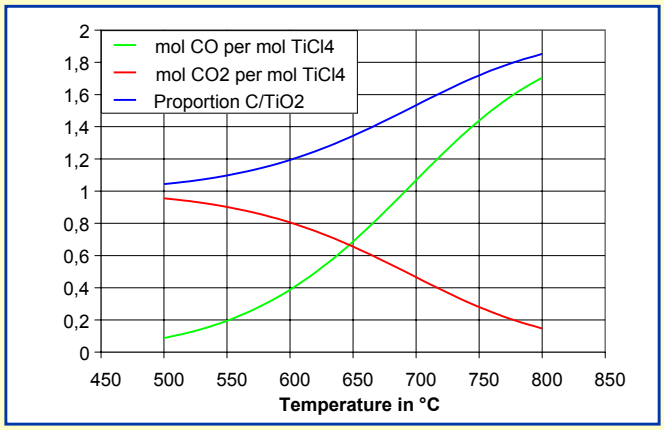
Titanium is produced by the Kroll process since 1946 with:

- low efficiency (batch wise operation)
- high cost
- complicated equipment
- low productivity (process takes up to six days)
- high energy consumption
- limited capacities for the increasing demand for titanium

→ **need for a faster and cheaper production process**

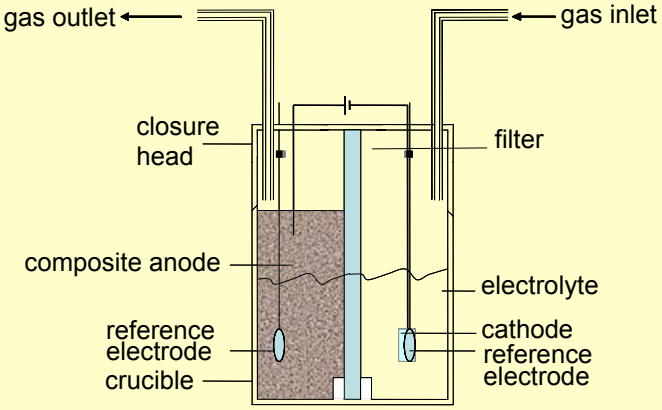
Composite anode:

- Anode composition (C, TiO_2) calculated according to the chlorination of pellets via packed bed process
- Reaction proceeds via the shrinking particle model → optimal composition matches the stoichiometric one
- Calculation via the „extend of reaction"-mechanism



Invention of the new IME-process:

Forming titanium by in-situ chlorination of a TiO_2 composite anode and electrolytic reduction of $TiCl_x$ at the cathode.



$TiCl_x \rightarrow Ti^{x+} + xCl^-$

cathodic deposition:

$Ti^{3+} + e^- \rightarrow Ti^{2+} + 2e^- \rightarrow Ti$

$TiO_2 + 2C + xCl \rightarrow TiCl_x + 2CO/CO_2$

Avoidance of Ti^{4+}

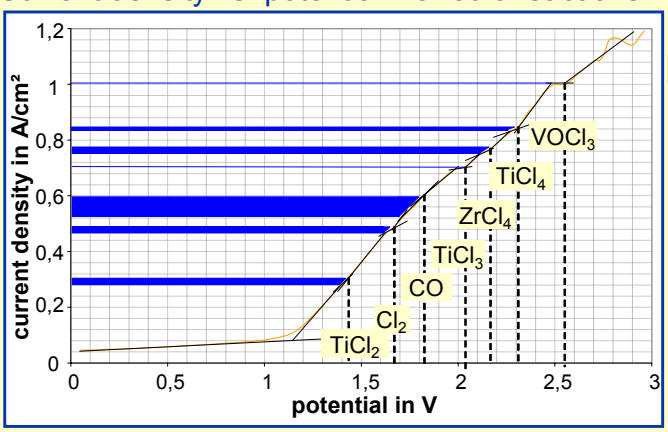
$Ti + 3Ti^{4+} = 4Ti^{3+}$

$Ti + Ti^{4+} = 2Ti^{2+}$

Work packages of the process development:

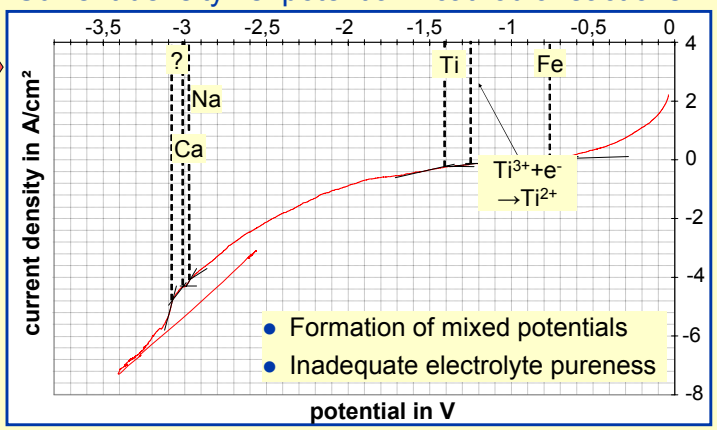
- Buildup of an electrolysis cell
- Electrolyte development
- Development of a TiO_2-C-composite anode
- Testing the feasibility of the proposed process

Current density vs. potential – anodic reactions



Experimental proof that $TiCl_2$ forms with priority

Current density vs. potential – cathodic reactions



Experimental proof that $TiCl_2$ is electrochemically reduced before other electrolyte components

Result:

It is possible to form titanium by in-situ chlorination of a TiO_2 composite anode and electrolytic reduction of $TiCl_x$ at the cathode.

Next steps:

- Testing of alternative electrolytes
- Define major process parameters (temperature, current density, $TiCl_2$-concentration)
- Improvement of the composite anode
- Testing of different cathode materials
- Improvement of electrolyte refining

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