Investigations on oxygen removal from molten TiAl scrap by metallothermic reduction

Motivation:

- Complex process chain and production rejections of up to 90% result in high production costs during manufacture of titanium aluminides
- Reducing manufacturing costs by recycling of strongly oxygenated scrap via:
  - utilization of industry-proven processes
  - highly flexible selection of input materials
  - in-situ adjustment of the alloy composition

Feedstock (production scrap) → Vacuum induction melting → Electro-slag remelting → Vacuum arc remelting → Product

- Input material contains more than 1000 ppm oxygen
- Melting of the scrap in a ceramic crucible with subsequent homogenization
- Calcium addition for deoxidization results in formation of a CaO-slag
- Residual oxygen content of about 700 ppm

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\begin{align*}
\text{Ca}_2\text{TiAl} + [\text{Ca}] &\rightarrow <\text{CaO}> \\
\text{TiAl} + [\text{Ca}] &\rightarrow <\text{CaO}>
\end{align*}
\]

- Solid \{ liquid \} \{ gaseous \}

- Remelting with a continuously activated reactive CaF$_2$-slag results in:
  - reduction of the oxygen content
  - removal of nonmetallic inclusions
  - almost no existence of shrinking holes

- Potential of bulk fluoridation
- Residual oxygen content below 500 ppm
- Further homogenization of the material

- Optional final remelting step in order to:
  - remove potentially objectionable calcium residues
  - remove last nonmetallic inclusions
  - adjust the designated crystal structure

- Safety remelting step with regard to existing standards

Selection of suitable ceramic linings:

- Y$_2$O$_3$ coated Al$_2$O$_3$:
  - Flaking of Y$_2$O$_3$ coating
- High purity CaO:
  - Promising durability

**Results:**

- Oxygen content below 500 ppm can be achieved
- Potential of „bulk fluoridation“ existent
- Decrease of production costs of about 30 – 40 %

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