PaGe_2025-10_MgORec-316L-PO-EBSD

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Abstract:

Every year, approx. 28 million tons of used refractories accumulate worldwide. The majority of them are used as aggregates for road construction (downcycling) or are deposited in landfills. For ecological and economic reasons, an increased research potential was identified in recent years, dedicated to increasing the recycling rate and finding new markets and application fields with a higher value of the refractory recyclates. The study presents the
current findings of the development of inert electrodes for the aluminum fused-salt electrolysis composed of steel and MgO gained from MgO-C recyclates. To withstand the chemical attack of molten aluminum and cryolitic melts, the metal-ceramic composites were preoxidized (PO) at 800 °C, 900 °C, and 1000 °C. The microstructure after each PO thermal treatment was analyzed. After PO at 800 °C, a $(Cr,Fe)_3O_4$ spinel-like phase and Fe-O Mg-O solid solution form. After PO at 900 °C, a larger amount of the Fe-O Mg-O solid solution and a $(Cr,Fe)_2O_3$ solid solution around the steel grains was identified. Furthermore, the electrical conductivity of the metal-ceramic-composites preoxidized at 900 °C amounts to $1.49 \cdot 10^2$ $S \cdot cm^{-1}$ and hence is in the range of carbon, which exhibits a value of $1.54 \cdot 10^2$ $S \cdot cm^{-1}$. Additionally, the impact of different preoxidation treatments at 900 °C by applying furnaces equipped
with electrical heating, natural gas burner, and microwave plasma burner on the microstructure was investigated.

Keywords:

MgO-C; recyclates; steel; oxidation; microstructure

Experiments:

- Processing - PaGe_028_CarbonBurnout_MgO_MgO-C-125µm-1000degC
- Processing - PaGe_029_Mixing_MgO-316L_40-60Vol
- Thermal Treatment - PaGe_030_ThermalTreatment_MgO-316L_40-60Vol-1350degC-2h-Ar
- Processing - PaGe_031_Mixing_MgO-316L_SinteredGranules-70-30Vol
- Processing - PaGe_032-Pressing_MgO-316L_SinteredGranules-70-30Vol-CIP-150MPa
- Thermal Treatment - PaGe_033_ThermalTreatment_MgO-316L_SinteredGranules-70-30Vol-1350degC-2h-Ar
- Thermal Treatment - PaGe_034_ThermalTreatment_MgO-316L-Composite_PreOxidation-800degC
- Thermal Treatment - PaGe_035_ThermalTreatment_MgO-316L-Composite_PreOxidation-900degC
- Thermal Treatment - PaGe_036_ThermalTreatment_MgO-316L-Composite_PreOxidation-1000degC
- Testing & Analysis - PaGe_037_SEM-EBSD_MgO-316L-Composite-AsSintered
- Testing & Analysis - PaGe_038_SEM-EBSD_MgO-316L-Composite-PO800

- Testing & Analysis - PaGe_039_SEM-EBSD_MgO-316L-Composite-PO900
- Testing & Analysis - PaGe_040_SEM-EBSD_MgO-316L-Composite-PO1000

Conclusions:

Metal-ceramic composites based on 316L steel and recycled MgO-C were successfully manufactured using cold isostatic pressing and pre-sintered agglomerates to introduce coarse grains into the composite material. The ceramic phase included MgO–C recyclates and sintering was conducted at 1350 °C under Ar atmosphere. Preoxidation thermal treatments at 800 °C, 900 °C, and 1000 °C were performed to study phase formation and oxidation behavior. During oxidation treatment, Fe migration from steel grains toward MgO leads first to the $(Cr,Fe)_2O_3$ phase followed by $(Cr,Fe)_3O_4$ spinel-like phase formation. In proximity to MgO grains, an Mg–O Fe–O solid solution phase was detected. With Fe tending to oxidize, the solid solution with MgO followed by Cr-rich phases is formed. The $(Cr,Fe)_3O_4$ phase is predominantly present at lower temperatures, while Mg–O Fe–O structures tend to be formed at higher temperatures, which indicates that more atoms of Fe migrate toward MgO grains. After preoxidation at 1000 °C, the formation of a Fe–Mg–O spinel phase was detected. All MgO grains reacted with steel forming a solid solution with FeO as well as a Fe–Mg–O spinel. After all MgO was consumed by this reaction, excessive Fe is oxidized to the hematite phase.

Figures:

8

Tables:

2

Number of References:

10

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Title

Anodes based on MgO-C recyclates and 316L steel for prospective aluminium fused-salt electrolysis application

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Linked experiments

Processing - PaGe_028_CarbonBurnout_MgO_MgO-C-125µm-1000degC

Processing - PaGe_029_Mixing_MgO-316L_40-60Vol

Processing - PaGe_031_Mixing_MgO-316L_SinteredGranules-70-30Vol

Processing - PaGe_032-Pressing_MgO-316L_SinteredGranules-70-30Vol-CIP-150MPa

Testing & Analysis - PaGe_037_SEM-EBSD_MgO-316L-Composite-AsSintered

Testing & Analysis - PaGe_038_SEM-EBSD_MgO-316L-Composite-PO800

Testing & Analysis - PaGe_039_SEM-EBSD_MgO-316L-Composite-PO900

Testing & Analysis - PaGe_040_SEM-EBSD_MgO-316L-Composite-PO1000

Thermal Treatment - PaGe_030_ThermalTreatment_MgO-316L_40-60Vol-1350degC-2h-Ar

Thermal Treatment - PaGe_033_ThermalTreatment_MgO-316L_SinteredGranules-70-30Vol-1350degC-2h-Ar

Thermal Treatment - PaGe_034_ThermalTreatment_MgO-316L-Composite_PreOxidation-800degC

Thermal Treatment - PaGe_035_ThermalTreatment_MgO-316L-Composite_PreOxidation-900degC

Thermal Treatment - PaGe_036_ThermalTreatment_MgO-316L-Composite_PreOxidation-1000degC

Attached files

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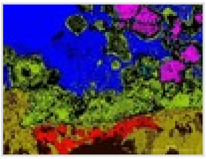

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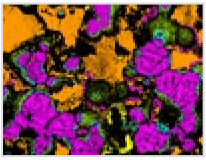

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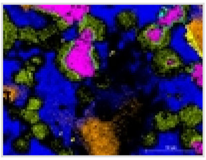

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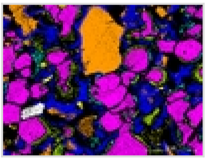

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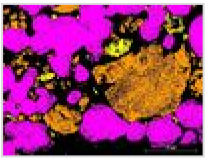

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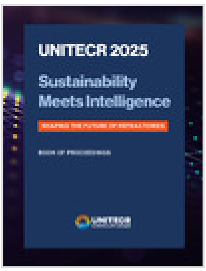

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