

H2EL-xxIrRuO

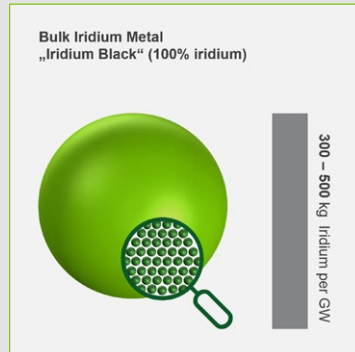
Iridium-Ruthenium Oxide

NEW!
Electrocatalyst
based on
Ruthenium

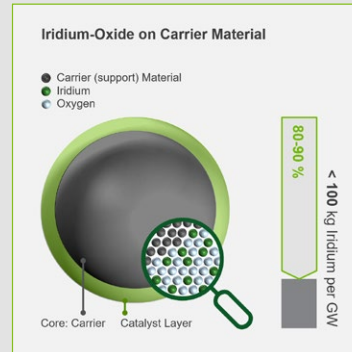


The new Ruthenium catalyst for PEM electrolysis:
Enabling the hyperscale with sustainable solutions

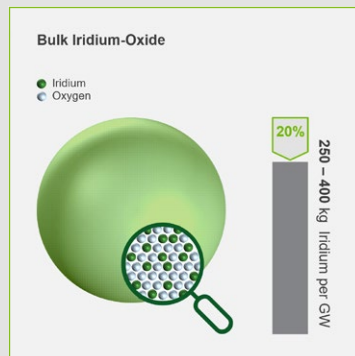
Catalyst solutions exist to enable the PEM ramp-up



Iridium black:
good activity,
good stability,
but bad ratio
surface / mass



- **Iridium Oxide** on Carrier (80-90% savings)
- Most of the **bulk replaced**
- **Oxidic Iridium species** with higher mass activity on surface



Iridium-Oxide:
Iridium is diluted
by oxygen: saves
20% with good
activity / stability

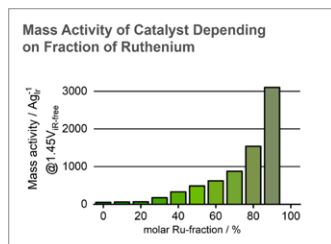


- Pure Ruthenium oxide is highly active but lacks stability
- **Mixed Oxide Concept** to overcome stability issue
- **Broadened toolbox for thrifting** of Iridium in PEM Electrolyzers

NEW

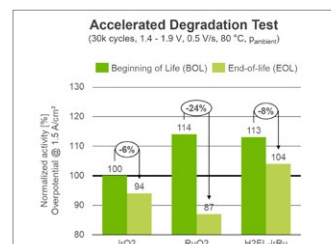
Leverage Ruthenium to tackle the Iridium challenge

Ruthenium oxide shows a superior Mass Activity also if stabilized



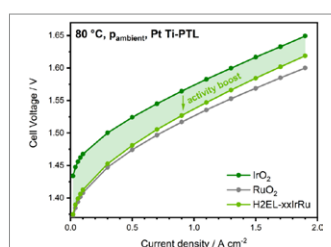
- Pure RuO_2 known to be unstable under operation conditions
- By adding Iridium the mixed oxide is stabilized
- With higher Ru content, the activity increases: up to 50 times higher mass activity with mixed oxides compared to pure IrO_2

Ruthenium oxide stability confirmed—at the same level as Iridium oxide



- BOL activity of mixed oxide comparable to Ruthenium oxide
- EOL activity remains 10 % higher than Iridium oxide
- Activity loss for mixed oxides at the same level as Iridium oxide

The activity boost with Iridium-Ruthenium oxides enables a higher performance of the catalyst, thus less tlr/GW



- Catalysts are to-date using in average 0.4 tlr/GW
- The new Ruthenium catalyst enables up to 85% Ir reduction vs. $IrO_2 \rightarrow < 0.1$ tlr/GW

Significant cost advantage of Iridium-Ruthenium oxide over Iridium oxide



- Reduced precious metal material cost by replacing Iridium with Ruthenium
- Reduced input power due to 10 times higher mass activity
- Further savings through optimization

*Prices November 03rd, 2023
At same amount catalyst
Financing not reflected