Preliminary studies of New Materials Based on Zirconia Doped with Mixed Rare Earth Oxides and their Potential Use as Thermal Barrier Coatings (TBC)

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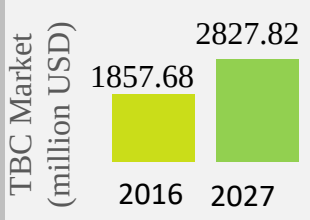
INTRODUCTION

1 TBC market



The TBC market will be **ACCELERATING** growing at a CAGR of nearly **7%**

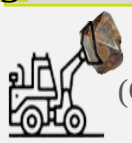
2 Recent materials used for TBC

ZrO_2 + rare earth oxides (REOs)

doped

- Improves the *thermal properties* of TBC ✓
- Improves *oxidation properties* ✓

3 REO Obtaining



MONAZITE mineral

$(Ce, La, Nd, Th, Y, Dy, Sm)(PO_4)$

Separation in individual REO

- Complex process
- High cost process

large quantities of chemical reagents

waste gas, waste water

I THE OBJECTIVE OF THE STUDY

What happens if we use these mixed REO sites ?!

IDEEA

MONAMIX PROJECT

Mixed REOs ✓ — Individual REOs ✗

ZrO_2 Doped with REO → Used in TBC

To increase the lifetime of Ni / Cr alloys ☑

transition

efficient economy in terms of **resource use**

II METHODS

Hydrothermal method

2

$ZrCl_4$ ***solution*** — ***Solution of lanthanides oxides*** — ***NH_3***

Hot mixing with stirring

Doped solution

Hydrothermal autoclave treatment (T,P,t)

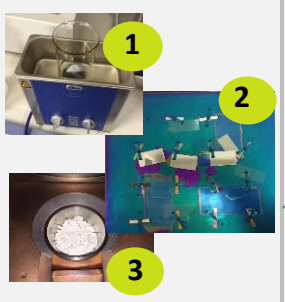
Filtration

Three stages washing

Drying

Dry ceramic Powders

3 **EB-PVD deposition**



1- preparation of the substrate;
2- fixing the substrate;
3 - material in the crucible;
4 – example of sample.

III SAMPLES

M_xZ_y8% La/ Nd/ Sm/Gd. powders	ZrO_2 doped with 8 wt.% La/ Nd/ Sm/Gd.
ZrO2-RE1 powders	ZrO_2 doped with mix REO.

NiCrAlY / ZrO2-RE1 / LZO / GZO depositions

Where: **LZO:** $La_2Zr_2O_7$
GZO: $Gd_2Zr_2O_7$

CONCLUSIONS

✓ The laboratory technology developed for the **synthesis of REO-doped ZrO_2 powders was demonstrated;**

✓ The XRD diffractogram of ZrO2-Re: **a solid tetragonal single-phase solution of ZrO_2.**

✓ ***Tickness TBC*** depsitions is **~11.5µm** : NiCrAlY 556 nm, ZrO_2-RE1 1,98 µm, LZO 4,25 µm
GZO 4,62 µm.

✓ **The thermal shock results** are **comparable to those of traditional YSZ** coatings with thicknesses> 100 µm.

✓ For 5% of the estimated need at European level in 2027, respectively a coverage capacity of 2150 m.p./year the estimated price is **4260.33 EURO/ Kg.**

IV RESULTS

1 Powders results

The Chimical analysis is in accordance with the designed Copositions.

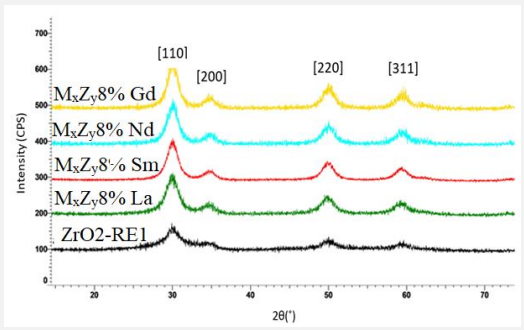


Fig. 1. X-ray diffractograms of the synthesized samples.

2 Depositions results

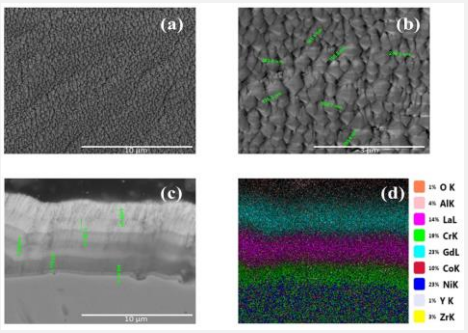


Fig 2. SEM images (X50,000):(a) and (b) the surface of multilayer coating on the Nimonic substrate after heat treatment at 1250 ° C (X 40,000); (c) cross section of multilayer coating on Nimonic substrate; and (d) elementary mapping after heat treatment.

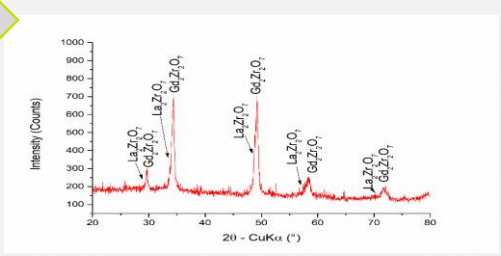


Fig 3. DRX spectrum of multilayer coating .

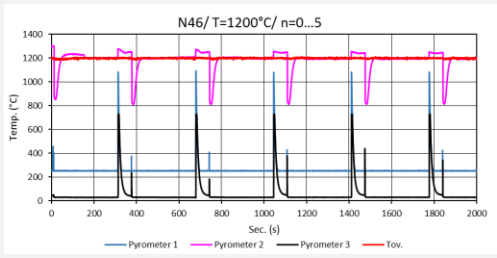


Fig 4. Figure Thermogram for thermal shock cycles 38–43, temperature range 800–1300 ° C

REFERENCES

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ACKNOWLEDGEMENT

Project ERAMIN 2 ID: 87 MONAMIX

Scan for *project details*

ERA·MIN 2
RESEARCH & INNOVATION PROGRAMME ON RAW MATERIALS TO FOSTER CIRCULAR ECONOMY