R & D in Ceramic Materials @ NIMP

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NIMP research on ceramic materials:

tradition (back to '50s) & expertise

+

new infrastructure (synthesis & characterization)

+

focus on new trends (e.g. nanostructuring)

=

development of new materials and technologies

➔ toward application oriented research

materials & composites for extreme conditions
(radiation, temperature, corrosion)

materials for electronic devices & sensors

materials & composites for energy related applications

new "-assisted" sintering equipments:

field assisted sintering (FAST or SPS)
pressure assisted sintering (HPS)
microwave assisted sintering (MWS)

aiming

- to solve typical ceramic synthesis problems like
  - high porosity, low density (HPS)
  - very high temperatures & grain growth (HPS, SPS, MWS)
  - long processing time & intermediate steps (SPS, MWS)
  - joining related problems (SPS, MWS)

- to approach new materials like
  - metalo-ceramic composites
  - intermetallics based composites

$SrZrO_3$

application:

- electrolytes in SOFC
- H_2 sensors
- high-k gate dielectrics

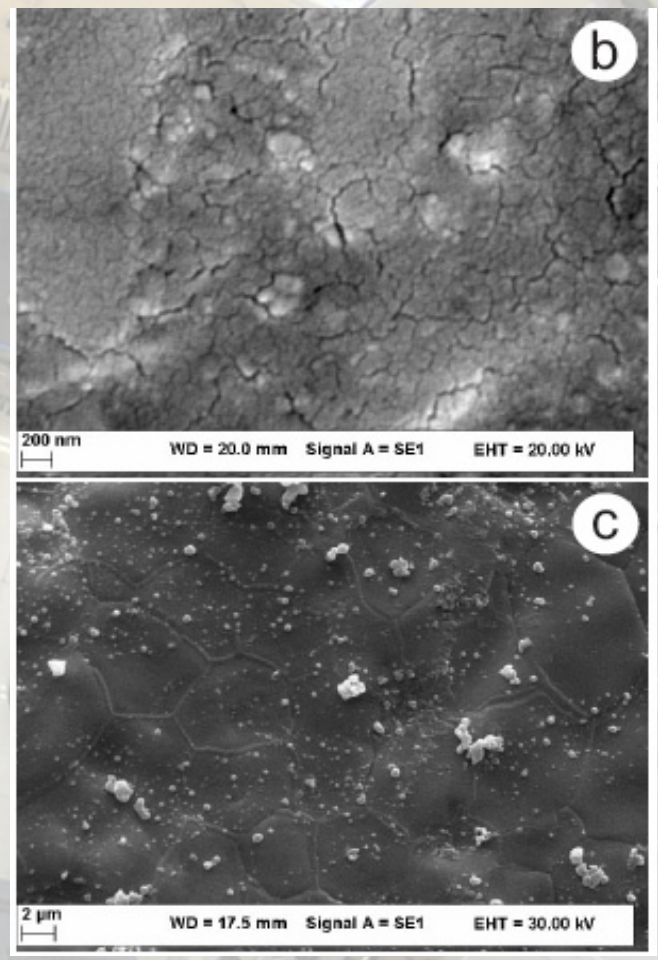
classic sintering vs. SPS

processing time: 48 h ➔ 8 h

density 92% ➔ ~100%

grain coarsening

J. Alloys & Comp. 509 (2011) 6395.



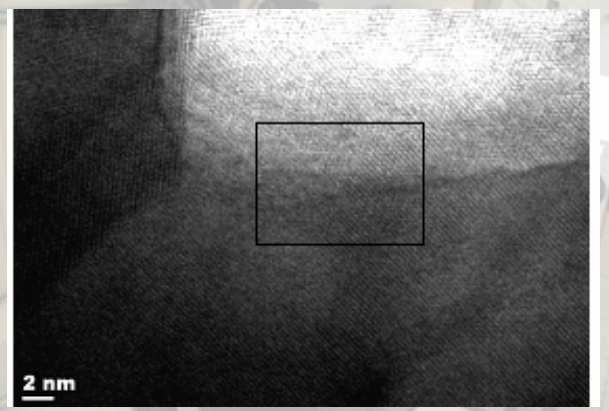
Classic (top) vs. SP (bottom) sintering

$Ln_{0.2}Ce_{0.8}O_{2-x}$ (Gd, Sm, Yb)

preserved nm grain size
short processing time

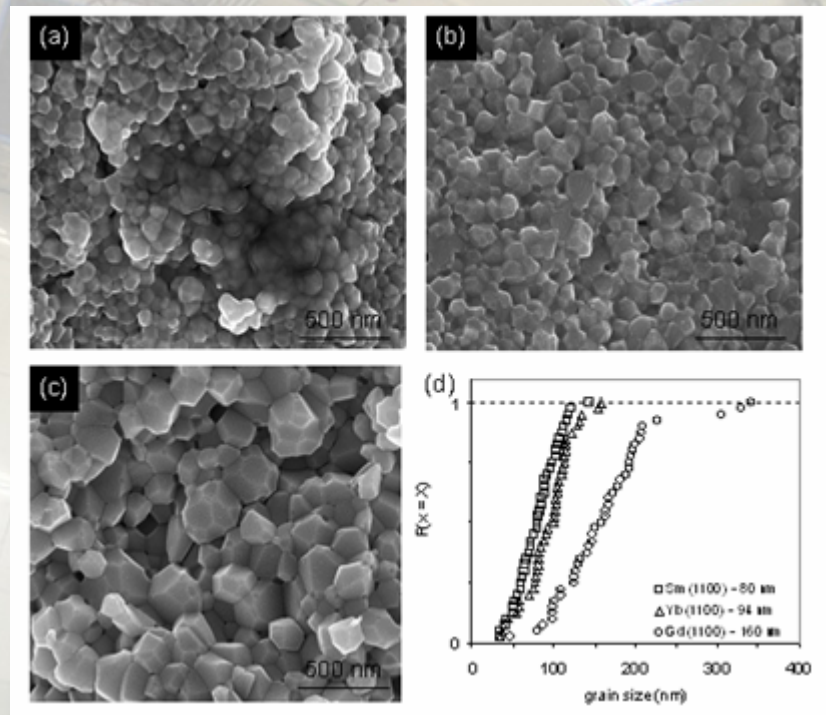
application:
- SOFC
- catalysts
- gas sensors

precipitate free grain bounderiees



HRTEM on $Sm_{0.2}Ce_{0.8}O_{2-x}$

J. Opt. & Adv. Mat. 13 (2011) 1110.



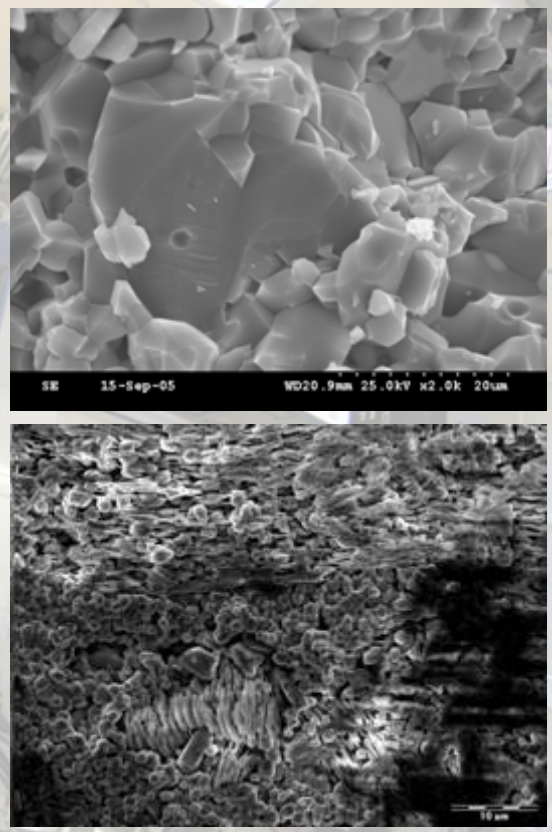
SEM on fractured compounds with
(a) Sm; (b) Yb; (c) Gd;
(d) distribution of grain size.

ZTA (Ca2+ + Mg2+) nanocomposites

application:
- shock thermal resistant materials

ZTA:
increased fracture toughness
double strenght

SPS:
very short time
high density, nm grains
lower temperature
(1750 C ➔ 1250 C)



Classic 1750 C (top) vs.
SP 1250 C (bottom) sintering

J. Eur. Cer. Soc. 27 (2006) 1379.

Sr_2FeMoO_6

application:
Spintronics

different routes
sol-gel
solid state reaction
+ SPS

detailed analysis of the relation:
transport&magnetic properties
vs. structure&morphology
(as resulting from preparation)

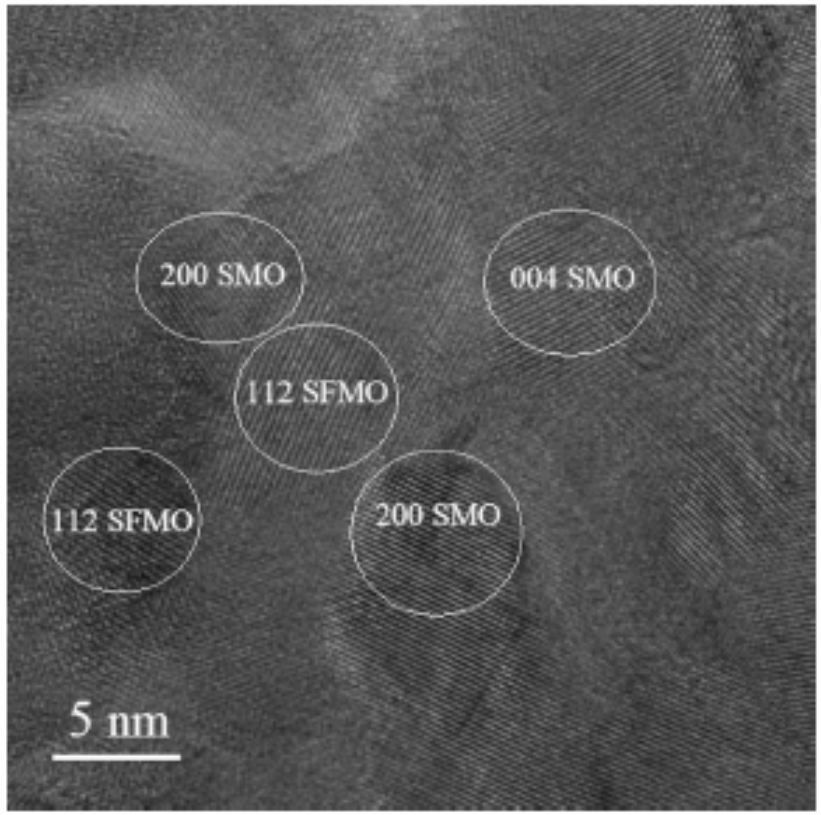


Fig. 9. HREM micrograph of the specimen calcined at 900 °C, 3 h showing two SFMO grains encompassed by three SMO grains; different lattice fringes associated with the both structures are marked in the image.

J. Eur. Cer. Soc. 33 (2013) 2483.

SiC complex composites

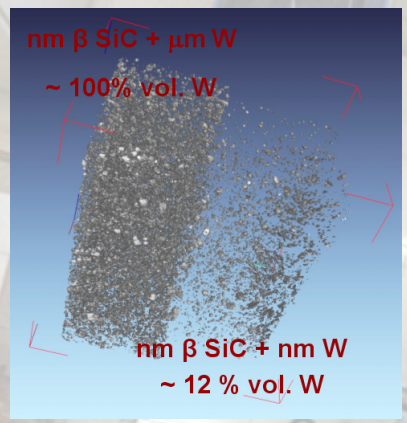
application: fusion related materials

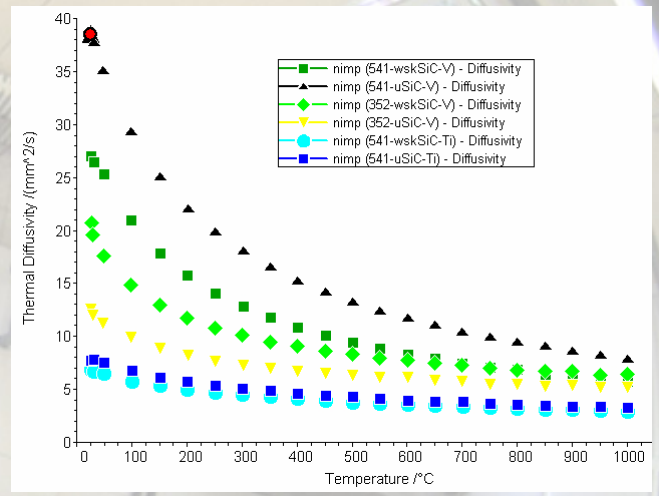
nm SiC + SPS/MWS
➔ to decrease porosity

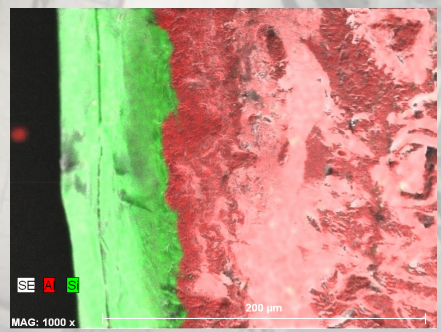
metal insertions
SiC (μm and wiskers)
oxides insertions
➔ to tune thermal prop.

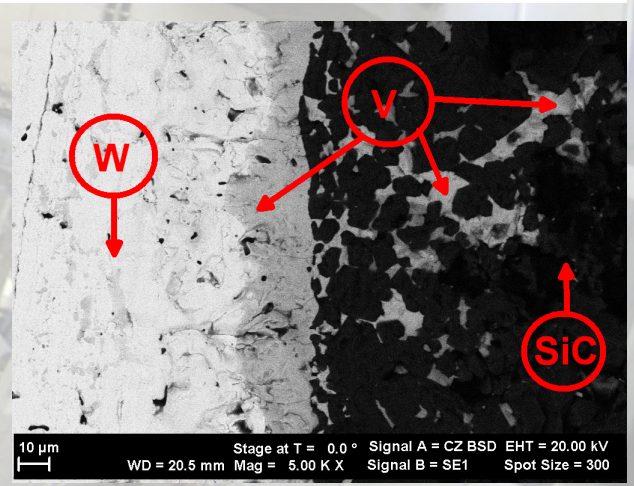
SPS technology
➔ joining to armor materials

Fus. Eng. Des. 88 (2013) 2598.







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Thank you for
your attention !