*
, ,

- -

- - -

(/ / , / / , / /)

.

. (YSZ) - .

) YSZ

. ( ) (

light-off

. cold-start

lean-burn

.

(λ>)

.

- YSZ – - :

-

.

.

.

CO

( ) . SO₂ NOₓ (UHC) CO₂

.

(TWC)

.[ ] NOₓ UHC CO

:

.

°C

( ) :

$$EMF = \frac{\Re T}{4F} \log \left[\frac{P_{O_2(\text{reference})}}{P_{O_2(\text{exhaust})}} \right]$$

.[ ]

( )

$P_{O2(exhaust)}$ $P_{O2(refrence)}$ F R T

.

cold start .

(ECU) . ,

.

.

.[   ]

.

,

.

.

.

°C

.[   ]

.[   ]

, .

.[ ]

.

50 wt% (YSZ)

50 wt% 50% wt TiO$_2$/ZrO$_2$ CeO$_2$/ZrO$_2$

.   SrZr$_{0.65}$Fe$_{0.35}$ CeO$_2$/SnO$_2$

[ ]

.   -   -

.

.

50 wt% ZrO_2/TiO_2 50 wt% CeO_2/ZrO_2

$SrZr_{0.65}Fe_{0.35}$ TiO_2 SnO_2

(PEG 3000)

(HEC)

YSZ

°C
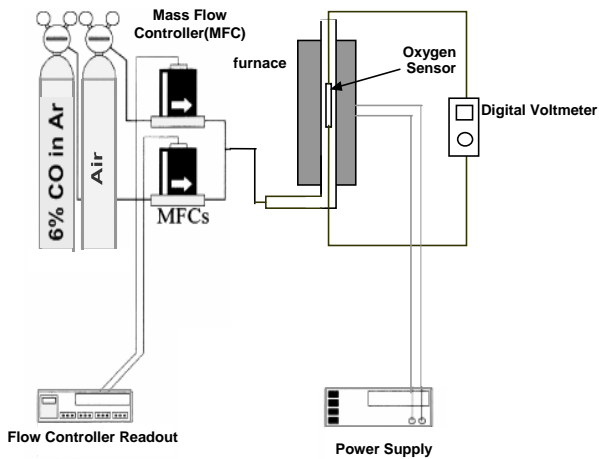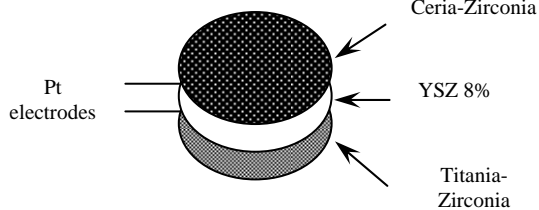
$ZrO(NO_3)_2$ $Y(NO_3)_3.6H_2O$

( )   (%   )

°C   °C

50 wt% CeO_2/ZrO_2

$Ce(NO_3)_3.6H_2O$

Ceria-Zirconia

YSZ 8%

Pt
electrodes

Titania-
Zirconia

50% wt   YSZ

P25) TiO_2 TiO_2/ZrO_2

$ZrO(NO_3)_2$ (

50 wt% CeO_2/SnO_2

-                          - SnO_2

wt% CeO_2/SnO_2

$SnCl_4$

YSZ

$SrZr_{0.65}Fe_{0.35}$

$ZrO(NO_3)_2$ xH_2O

$Sr(NO_3)_2$ $6H_2O$ $Fe(NO_3)_3$ $9H_2O$

oven

°C

°C

°C

SEM)   (XRD)

YSZ   YSZ

°C   bar

(   )   screen printing
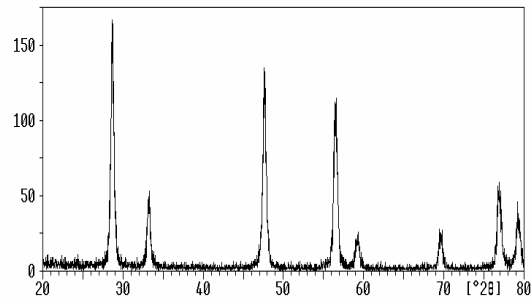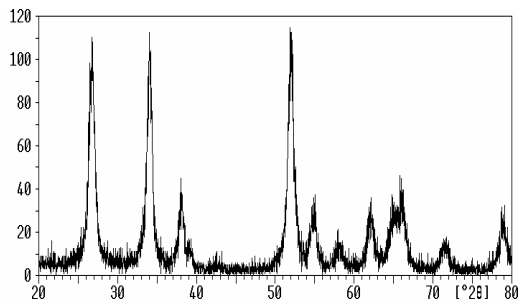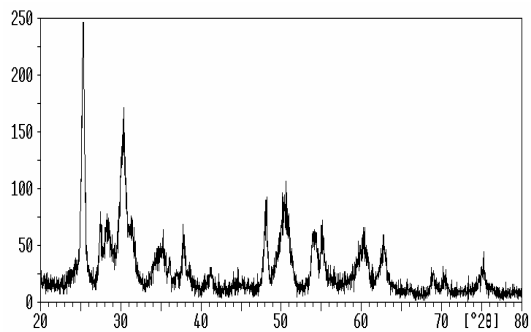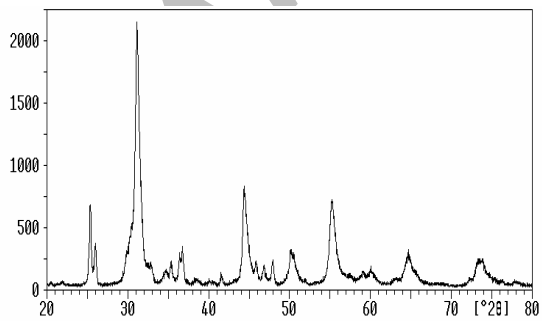
YSZ

λ .   λ

λ   °C

Ar   % CO

(MFC)

CE02

. **°C** **CeO₂** **XRD** :

Z-SN02

. **°C** **SnO₂** **XRD** :

TiO₂/ZrO₂ **XRD** :
. **°C**

. **SrZr₀.₆₅Fe₀.₃₅O₃** **XRD** :

TiO₂/ZrO₂ YSZ   YSZ   SEM
.   ( )   ( )

(SEM)   (XRD) X

.

.

YSZ   XRD   ( )   ( )

CeO₂ 50 wt% TiO₂/ZrO₂ 50 wt% CeO₂/ZrO₂

.   SrZr₀.₆₅Fe₀.₃₅   SnO₂
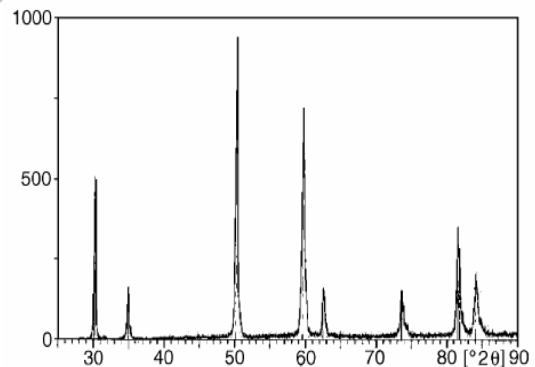
solid   ( ) ( ) ( )
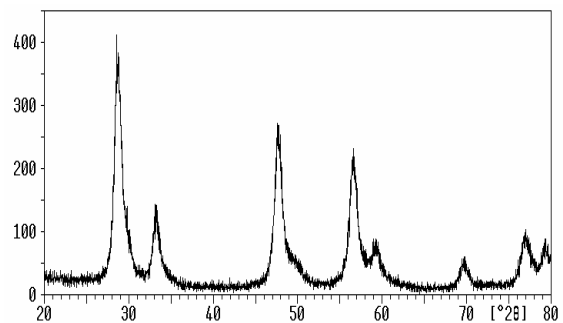
50 wt% CeO₂/ZrO₂   YSZ   solution
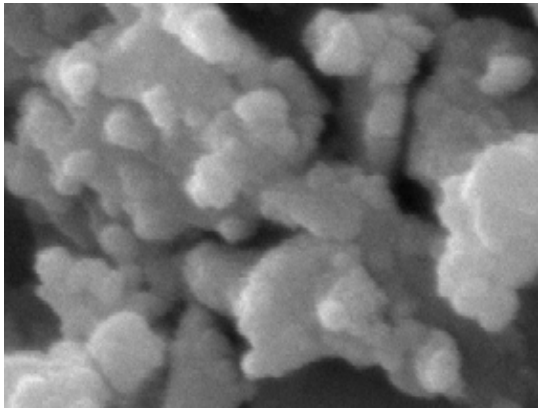(Anatyse)

.   50 wt% TiO₂/ZrO₂

( ) ( ) ( )

.

. **°C**   **YSZ** **XRD** :

CeO₂/ZrO₂ **XRD** :
. **°C**

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SnO₂ TiO₂/ZrO₂ CeO2/ZrO2   SEM

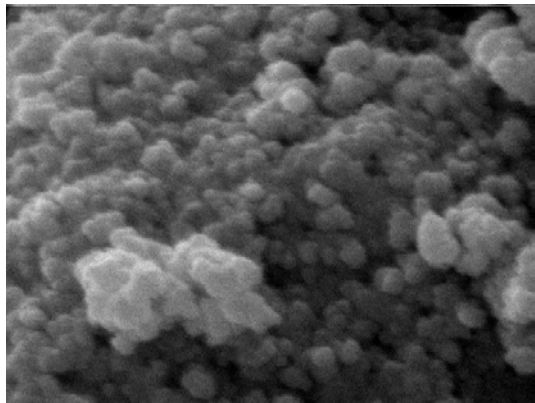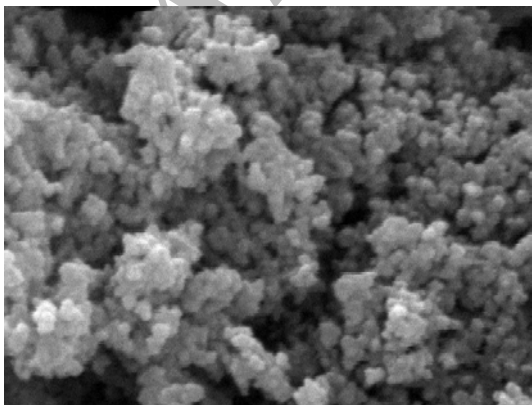( ) ( )   CeO₂

.   nm

Acc.V   Spot Magn Det ├──────┤ 500 nm
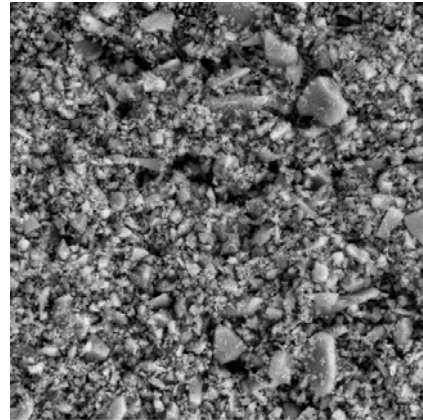29.0 kV 2.0 40000x

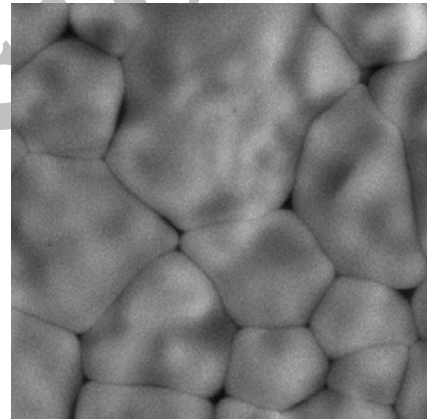**CeO₂/ZrO₂**   **SEM**   :

.

Acc.V   Spot Magn Det ├──────┤ 500 nm
29.0 kV 2.0 32000x

TiO₂/ZrO₂   **SEM**   :

.

.   **SnO₂**   **SEM**   :

SEM MAG: 2.00 kx   DET: BSE
HV: 25.0 kV   DATE: 01/08/05   20 μm   Vega @Tescan
VAC: HiVac   Device: MV2300   Obducat CamScan

.   **YSZ**   **SEM**   :

SEM MAG: 10.00 kx   DET: BSE
HV: 25.0 kV   DATE: 01/08/05   5 μm   Vega @Tescan
VAC: HiVac   Device: MV2300   Obducat CamScan

.   **YSZ**   **SEM**   :

( )

.   nm   YSZ

mixed-oxide

.

.

( )

.   YSZ

.

'

.

:
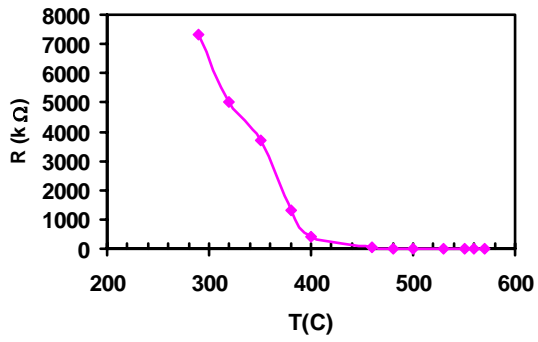
(YSZ)

.

( )
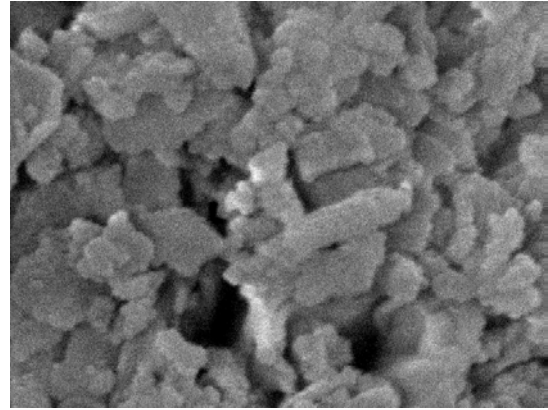
.   **CeO₂**   **SEM**   :

.

SrZr₀.₆₅Fe₀.₃₅O₃   SEM ( )

mixed-oxide   .

.   **YSZ**   :

.

°C

.   ° C   YSZ

.

.

YSZ

.

YSZ

.   (LSF   )   **SrZr₀.₆₅Fe₀.₃₅O₃**   SEM   :

LSF   . ° C

Ar/CO GAS MIXTURE

E.M.F. (mV)

T=500 C
T=550 C
T=600 C

λ

°C

Ar % CO

λ   ( )

λ =

: SnO₂

Ar/CO GAS MIXTURE

E.M.F (mV)

T=400 C
T=500 C
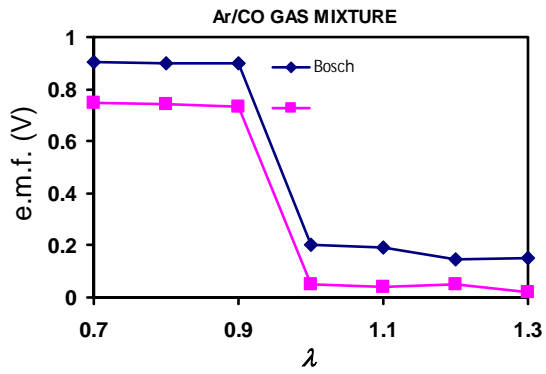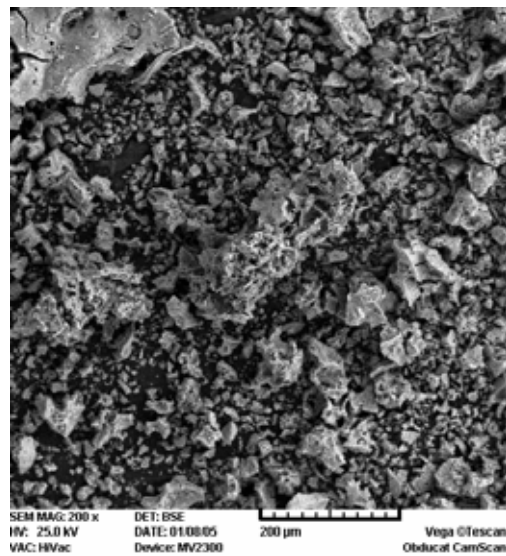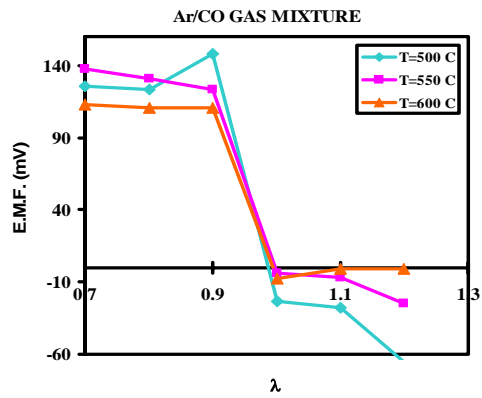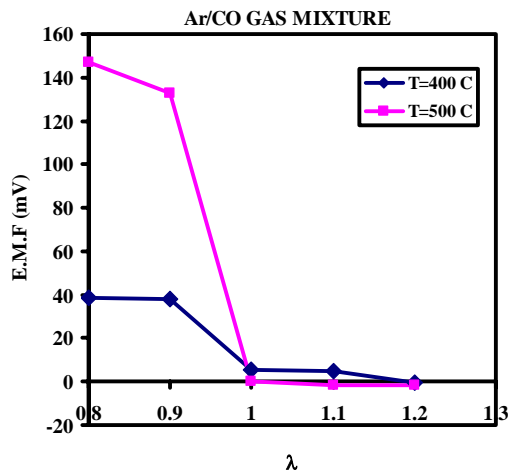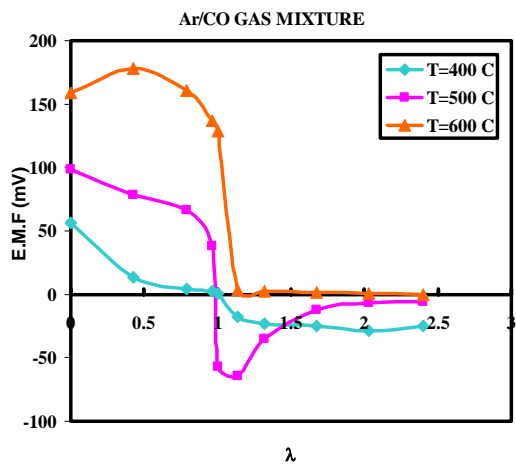
λ

CeO₂/ZrO₂   YSZ

SrZr₀.₆₅Fe₀.₃₅O₃   TiO₂ SnO₂

λ

( ) ( )

: TiO₂

Ar/CO GAS MIXTURE

E.M.F (mV)

T=400 C
T=500 C
T=600 C

λ

He/CO GAS MIXTURE

e.m.f. (mV)

350 'C
400 'C
450 'C

λ

: CeO₂/ZrO₂

:

. SrZr₀.₆₅Fe₀.₃₅

λ=1

°C .

( ) $SrZr_{0.65}Fe_{0.35}O_3$

% Ar

( ) .

Amperometric oxygen sensor

E.M.F. (mV)

169
149
129
109
89
69
49
29
9
-11
-31

T=400 C
T=500 C
T=550 C
T=600 C

0.8   0.9   1   1.1   1.2   1.3   1.4   1.5

λ

current (mA)

1
0.1
0.01
0.001

0.3   0.35   0.4   0.45   0.5   0.55   0.6   0.7

10% O2
20% O2
30% O2
Ar

polarizatin Voltage (mV)

:
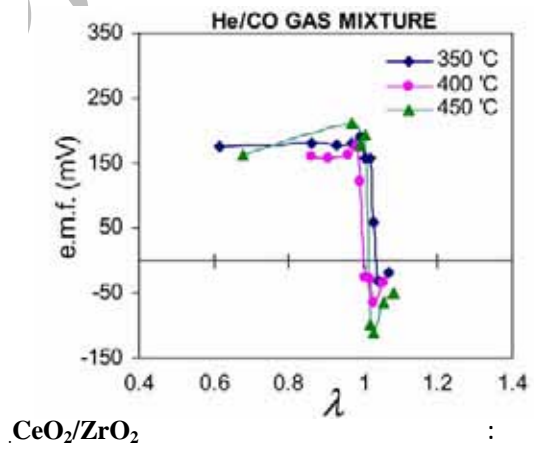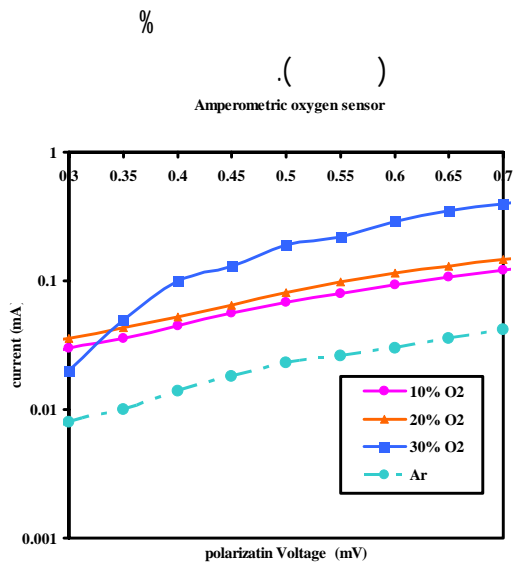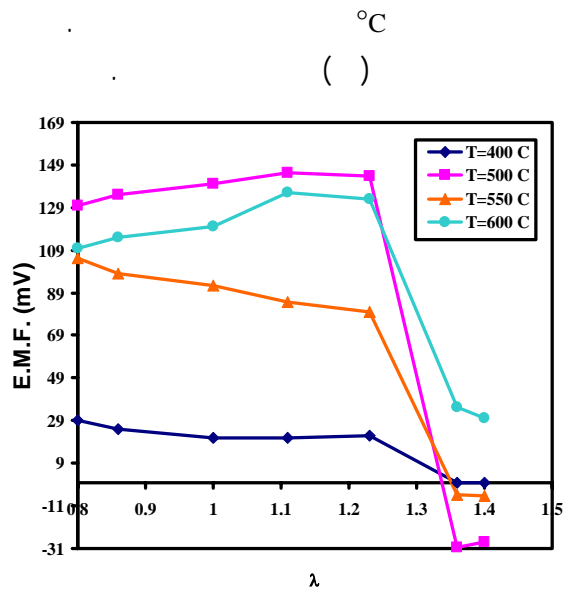
.TiO_2/ZrO_2 CeO_2/ZrO_2

:

.$SrZr_{0.65}Fe_{0.35}O_3$

.

(lean region ، $λ >$)

.

lean burn

lean

.

TiO_2-ZrO_2 CeO_2/ZrO_2

. °C

°C −

.

−

$SrZr_{0.65}Fe_{0.35}O_3$ −

.

.

.. $ZrO_2 – CeO_2$

Ce^{+4} Ce^{+3}

voltage (mV)

140
120
100
80
60
40
20

600 C
550 C
500 C
400 C

0.8   1   1.2   1.4   1.6   1.8

λ

.

:

Zr .
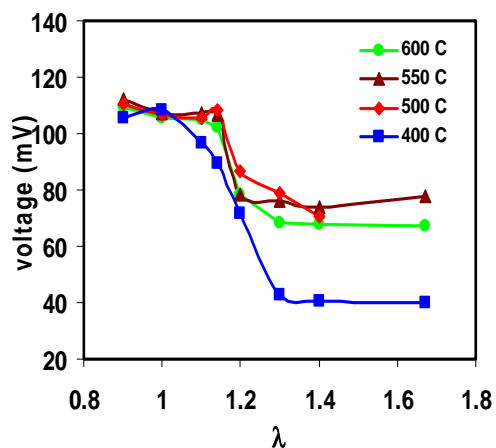
TiO_2/ZrO_2 CeO_2/ZrO_2 .

SnO_2-ZrO_2 CeO_2/ZrO_2

.

.

OSC (Oxygen Storage Capacity)

.

YSZ   –   –   mixed – oxide

planar   .

.

.   YSZ

Ti   .

.   Ce

.   cold start   OSC

.   .

$\lambda=1.0$

.

.

.   .

$\lambda =$,   .(°C   ) .

.

$\lambda =$,

.

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