

R&D

R&D

(PTFE)

$$\frac{\text{mg}}{\text{cm}^2}$$

$$/ \frac{\text{mg}}{\text{cm}^2}$$

$$/ \frac{\text{mg}}{\text{cm}^2}$$

%

[] .

Appleby .

Kordesh



)

(

PTFE

PTFE

%

(PTFE)

%

[]

/

)

.(

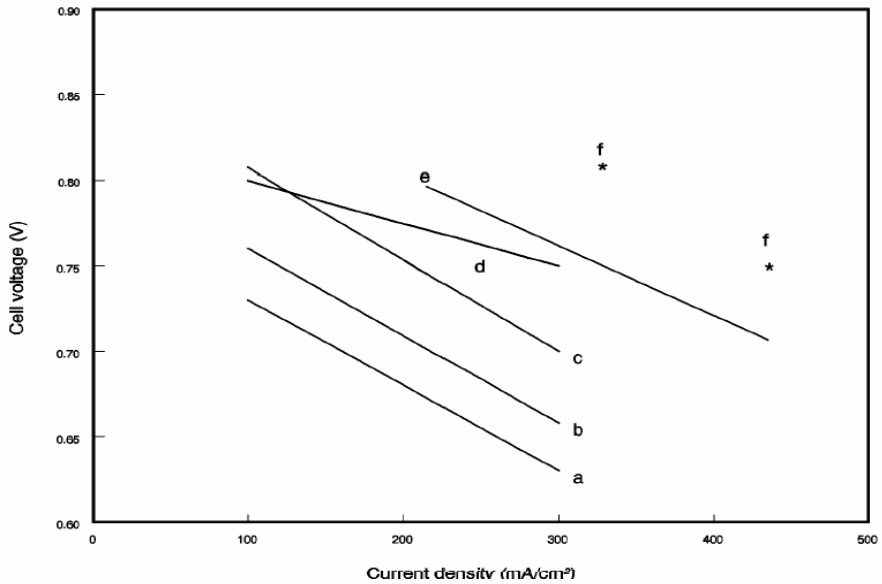
H₂S

°C

$$\frac{A}{cm^2}$$

$$\frac{A}{cm^2}$$

[]



$\left| \frac{mg}{cm^2} \right.$ °C :
 $\left| \frac{mg}{cm^2} \right.$ / °C :
 °C :
 Ft^2 °C :
 [] °C :

[]

$\frac{mgpt}{cm^2}$	$\frac{mgpt}{cm^2}$	$\frac{mgpt}{cm^2}$	
$\frac{mgpt}{cm^2}$	$\frac{mgpt}{cm^2}$	PTFE $\frac{mgpt}{cm^2}$	
		(Ta)	
SiC PTFE	PTFE SiC		
% H ₃ PO ₄	% H ₃ PO ₄	% H ₃ PO ₄	

$\frac{mw}{cm^2}$ $\frac{mw}{cm^2}$

 [].

(Li-NiO)

Li-NiO

:(LiFeO₂)

$$\frac{Ni^{2+} \cdot CO^{2+}}{Scm^{-1}} \times \frac{Fe^{2+}}{Scm^{-1}} \times \frac{LiFeO_2}{(Li)}$$

(Li/K)

:(LiMnO₃)

[], O₂ CO₂

$$S_{LiMnO_3} = K(P_{O_2})^{0.25} (P_{CO_2})^{-0.5}$$

%

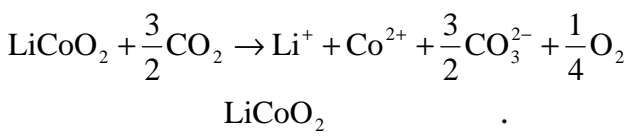
:(LiCoO₂)

LiCoO₂

CO₂

NiO

LiCoO₂





- :

/ / :

DE-03-01 :

$$S_{LiCoO_2} = 1/26 \times 10^5 (P_{CO_2})^{1.4} (P_{O_2})^{-0.30}$$

/ Scm⁻¹

LiCoO₂

Mg, Cr, Ni, B, Al

NiLi_x O_{1-x}

LiCoO₂

(1S.cm⁻¹)

[] .

S.cm⁻¹

LiMg_{0.05}CoO₂

Li/Na

Li/K

Li/Na

	ERC MTU	Li Li/K
	IHI, MC-power-Melco	Li/Na

%) LiAlO₂

() °C (

mm

(62% mol Li₂CO₃ , 38mol% K₂CO₃)

%

%

)
 K_2CO_3 Li_2CO_3

(
 Na_2CO_3

[]

-
-

$LiAlO_2$

$\gamma - LiAlO_2$ (γ, β, α)

$\alpha \quad \gamma$

$LiAlO_2$

$\alpha \quad \gamma$

$LiAlO_2$
 $\gamma - LiAlO_2$ $\alpha LiAlO_2$

LiAlO_2

 γ α α

 α -LiAlO₂

 α °C

 γ LiAlO₂ °C

 ()

	<650 °C	> 700 °C
γ -LiAlO ₂	Change to α	Stable
α -LiAlO ₂	Stable	Change to γ
β -LiAlO ₂	Unstable	Unstable

α LiAlO₂

 α LiAlO₂ ERC

 [].

MCP ERC

[] .

Ni- Cr /Ni- Al / Ni- Al- Cr μm % / $\frac{m^2}{g}$	Ni + %Cr	Pt , Pd , Ni	
NiO- MgO . μm % % / (mm) $\frac{m^2}{g}$	Ni	Ni Ag ₂ O	
α, γ - LiAlO ₂ $\frac{m^2}{g}$	LiAlO ₂ α, β, γ	MgO	



- :

/ / :

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/ (mm)	$\frac{m^2}{g}$ / mm		
Li K Li - Na Li - Na / (mm)	Li K / mm	% Li %Na Li / Na% % K / %	(wt%)

(ERC)

MW

ERC

[]

FETC (DOE)

FETC

:

ناقص فرستهای پیشنهادی



مگفا

(تولع سازمان گسترش و توسعه صنایع ایران)

- :

/ / :

DE-03-01 :

[].

IHI Sanyo

(Toshiba)

(Hitachi)

[].



NiO Co	LiCoO ₂	
ZrO ₂	/	
k ₂ wo ₄	k ₂ wo ₄	
30Cr-45Ni-7Al-3Y-15Fe	Cr-Ni-Al-Y-Fe	
50Ni-5Al 45Cu Ni Cu	Cu-Ni-Al	



- :

/ / :

DE-03-01 :

Hitachi , IHI
(KW) IHI .

[] .

ECN , ANSALDO , MTU

MTU

ECN

(ARGE MCFC)

MTU Fridrichshafen

:() Haldor Topsoe

:() Elkraft

:() Ruhrgos

:RWE

ERC		

[] .

:

ARGE MCFC .

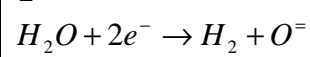
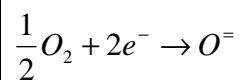
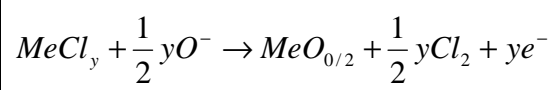
(SOFC)

()

EVD

EVD

O₂/H₂O



(TSOFC)

/

¹ Electrochemical Vapor Deposition

	/	LaMnO ₃	
EVD	μm	ZrO ₂ (Y ₂ O ₃)	
	μm	LaCrO ₃	
EVD	μm	Ni-ZrO ₂ (Y ₂ O ₃)	

)

[]:(

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-



- :

/ / :

DE-03-01 :

-

-

-

(SOFC)

()

(Ni)

(YSZ)

Ni

YSZ

YSZ

YSZ



Ni- YSZ

Ni- YSZ

Ni/YSZ

[] .

.(La ,Sr)MnO₃ (LSM) .

·
·

LaMnO₃

()

(LSM)

[] .

LSM

:M) La_{1-x}M_xCrO₃

(

ABO₃

B A

LaCrO₃

(interconnect)

La_{0.85}Sr_{0.15}CrO₃ (LSC-15)

) B

LSC-15

(ABO₃)

LSC-15

Ni	Cr	W	CO	Fe	Mo	Mn	Si	Al	C	La	B
52-57	22	14	5	3	2	0.5	0.4	0.3	0.1	0.02	0.015

KW

- Institute of Gas Technology
- Ceramatec
- Technology managements Incorporated
- Allied signal Aerospace corporation



- :

/ / :

DE-03-01 :

- Department of Energy (DOE)
- Federal Energy Technology center
- National Institute of Standard and Technology
- Department of Defense
- Gas Research Institute
- Electric Power Research

(+)

KW

[]

DOE

%

		(LHV)	
		%	
		%	



- :

/ / :

DE-03-01 :

		%	
		%	
		%	
		%	

/

در چهارمین برنامه تحقیقاتی بودجه اختصاص یافته به پیل سوختی اکسید جامد در اتحادیه اروپا ۱۱/۹ میلیون یورو بود. این بودجه ها بین ۵ مرکز تحقیقاتی در اروپا توزیع شد.

- RISO National Laboratory (UK) -
- Cream Research (UK) -
- Siemens (DE) -
- Gas TEC (NL) -
- Bertin Technology (FR) -

RISO National Laboratory (DK) BRITE-EURAM



- :

/ / :

DE-03-01 :

Sulzer Rolls-Royce (UK)

Hexis (CH)

Rolls-Royce

(BG)

Alstom

Alstom

BG

Sulzer Hexis

Sulzer

[]

EVD CVD

NIMC "

[]

(SOFC)

(ETL)

Moon light/New Sun Shine



- :

/ / :

DE-03-01 :

MOON LIGHT/NEW SUN SHINE

Wet (NIMC)

wet

interconnect

wet

(wet)

Ni/YSZ

(ETL)

YSZ NiO

MOON LIGHT/NEW SUN SHINE

()

MOON LIGHT/NEW SUN SHINE

NEDO

MOON LIGHT

()

(NSS) NEW

MOON LIGHT

NEDO

SUN SHINE

KW

KW



- :

/ / :

DE-03-01 :

()

KW	()
W / cm^2	
KW	()
h %	

NEDO

NIPPON Steel Corp. , Kyush EPC , TOTO

) KW TOTO/ Kyush Electric power (wet
 Nagasaki /Electric power Mitsubishi Heavy Industries (MHI)
 KW Spray Coating
 Lo-Sintering MHI Nagasaki
 KW Chubu Electric power/ MHI Kobe
 KW TOKYO Gas



- :

/ / :

DE-03-01 :

wet :

Para-sulfonated Polystyrene

(PTFE)

Poly benzimidazole (PBI)

Electro Osmotic () : Drag
(PBI)
(μm)

PTFE Nafion324 (

(Binder)

Nafion

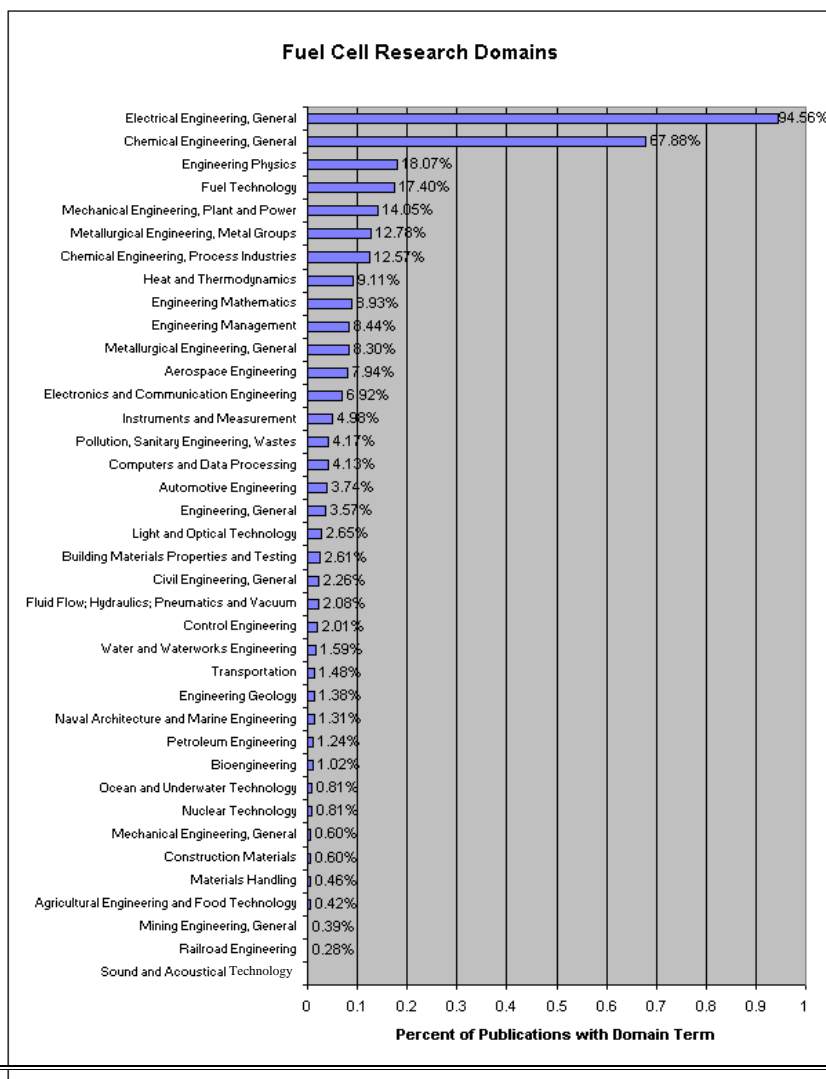
()

[] .

()

[] (/ mgPt/cm²).

R&D



/

/

(/) (Fuel Technology)

(/)

(/)

(/)

(/)

)

:(T)

(

SOFC

)

:(M)

(

(

)

:(A)

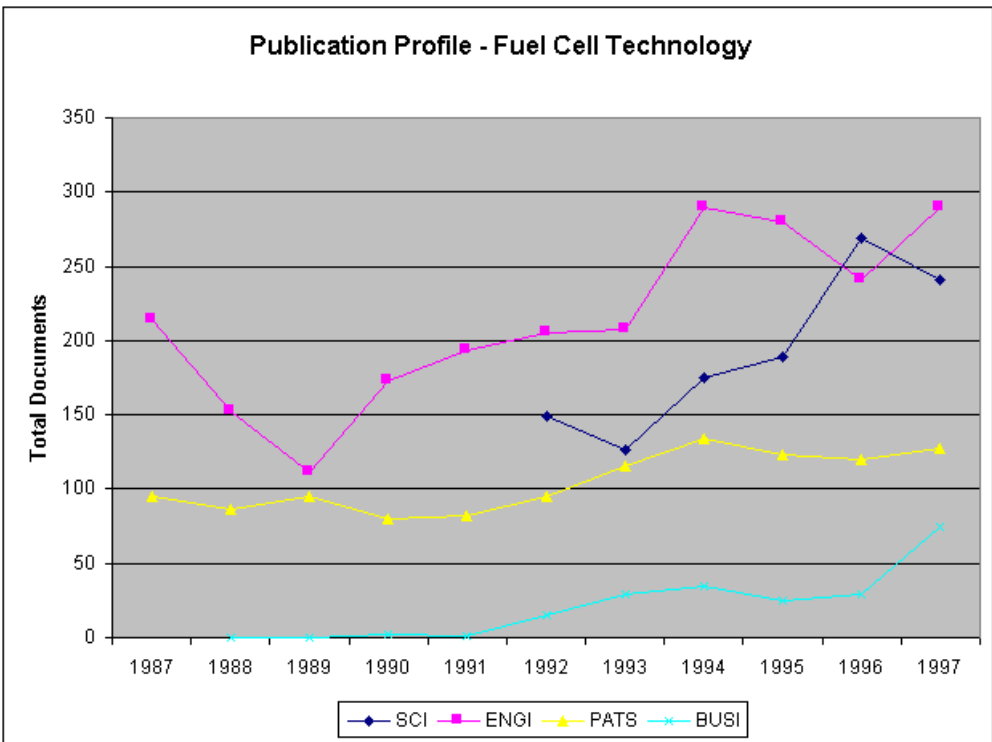
:(P)

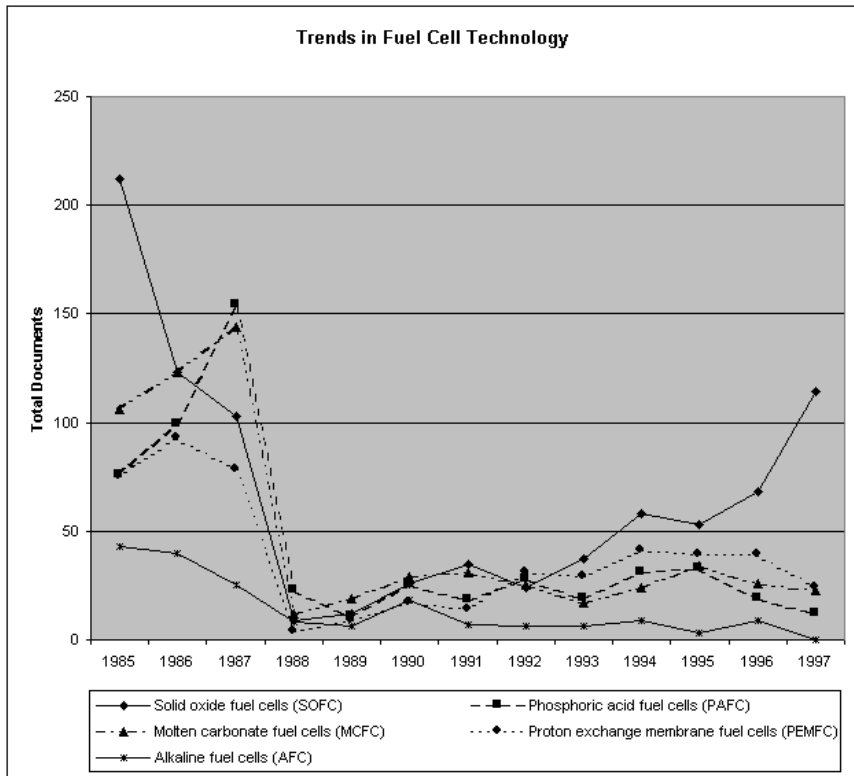
(T)

(A)

(%)

[].





$$= \frac{j+1}{j}$$

	SOFC (/)	SOFC (/)
	PEM (/)	AFC (/)
	MCFC (/)	MCFC (/)
	AFC (/)	PEMFC (/)
	PAFC (/)	PAFC (/)

NASA

)

(

:

(Zirconia)

ناقص فرمتهای زیرمجموعه



مگفا

(تابع سازمان گسترش و توسعه صنعتی ایران)

- :

/ / :

DE-03-01 :

.(

%

%

/

- :

/ / :

DE-03-01 :

%

\$

:(PEMFC)

H⁺

(%)

CO₂

:(A)

:(G)

:(C)

/ %

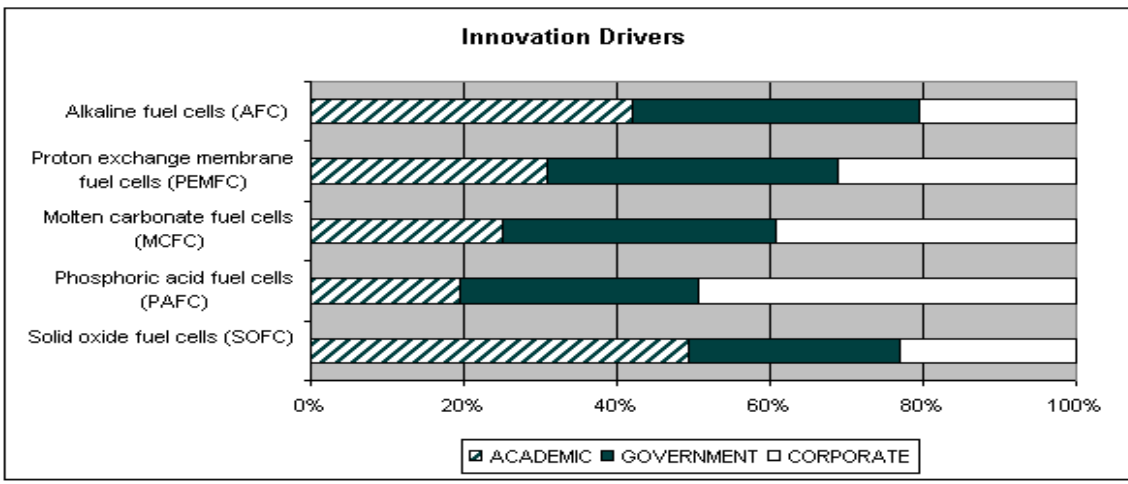
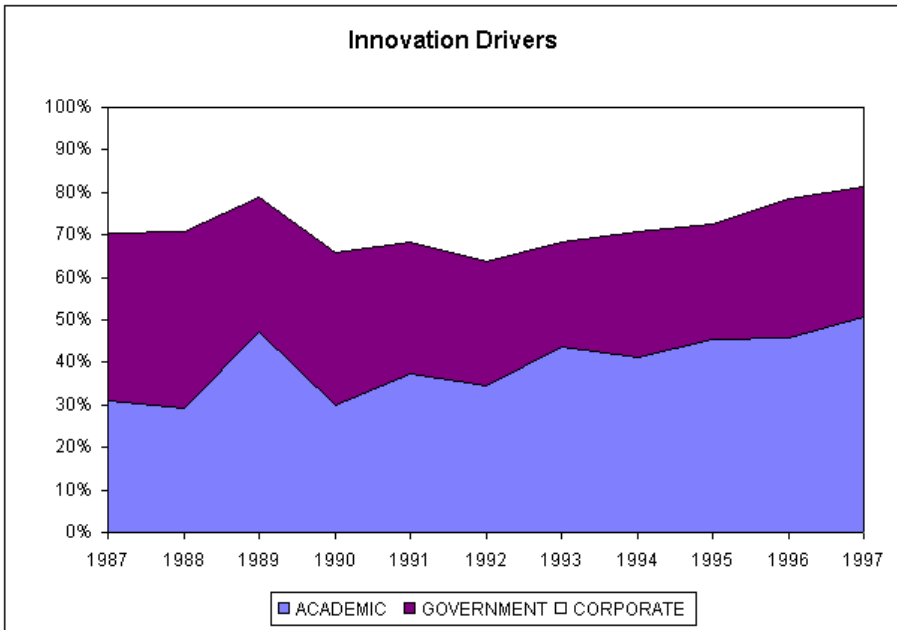
/ %

/ %

(/ %)

(/ %)

(/ %)





- :

/ / :

DE-03-01 :

1. (I)Westinghouse Electric Corp.
2. (G)Riso National Lab, Denmark
3. (A)Imperial College of Science & Technology
4. (A)University of Ljubljana
5. (G)Forschungszentrum Juelich G

1. (I)Westinghouse Electric Corp.
2. (I)Energy Research Corp.
3. (I)Gilbert/Commonwealth Inc.
4. (G)CNR Inst for Transformation
5. (I)Mitsubishi Electric Corp.

1. (I)Mitsubishi Electric Corp.
2. (A) Delft Univ of Technology, Denmark
3. (A) Illinois Inst of Technology
4. (I) GE, Corporate Research & Development
5. (G) Netherlands Energy Research

1. (G) Los Alamos National Laboratory
2. (A) Texas A&M University
3. (I) Ballard Power Systems, Inc.
4. (A) Royal Military College of Canada
5. (G) Paul Scherrer Institute

:

1. (G) NASA
2. (A) Technical Univ Graz, Graz, Austria
3. (I) International Fuel Cells Corp.
4. (A) Royal Inst of Technology
5. (G) Inst for Hydrogen Systems

(I)

(G)

(A)