

\* , \*\* , \* , \*\* , \*

\* (KIST)

\*\* (KJIST)

I.

가 , . ,

가 , 가

가

가 .

,

.

가 , MEMS (microelectromechanical system),

가 .

가 가 . [1]

● Miniaturization ( ) :

가 가

● Stability ( ):

- No self-discharge: 가 가

- On-chip power source: power source on-chip 가 가

- Resistance to vibration:

20

가

1983 Kanehori [2] CVD  
 $\text{Li/Li}_{3.6}\text{Si}_{0.6}\text{P}_{0.4}\text{O}_4/\text{TiS}_2$   $\text{Li/Li}_2\text{O}-\text{B}_2\text{O}_5-\text{Li}_2\text{SO}_4/\text{TiS}_2$ ,  $\text{Li/Li}_2\text{S}-\text{SiS}_2-\text{P}_2\text{S}_4/\text{V}_2\text{O}_5-$   
 $\text{TeO}_2$  가 가 .[3,4] , Eveready Battery  
 Com. S. Jones  $100 \mu\text{A}/\text{cm}^2$  10,000 -  
 $\text{Li/Li}_3\text{PO}_4/\text{Li}/\text{Li}$  .[5]

가

CMOS

on-chip standby power 1 .[1]

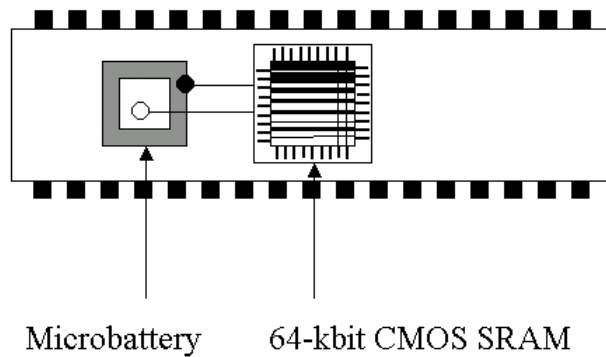


Figure 1. 가 On-chip CMOS SRAM .[1]

1993

Oak Ridge National Laboratory(ORNL)

LiPON

4.4 -

2.5V

가

가

[6,7]

가

가

가

II.

II-1.

/ /

2

Si

가

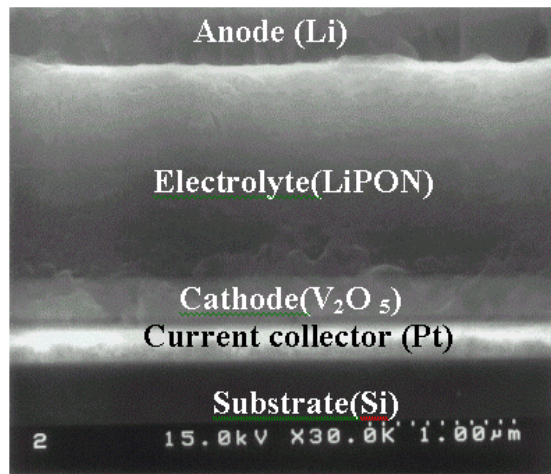
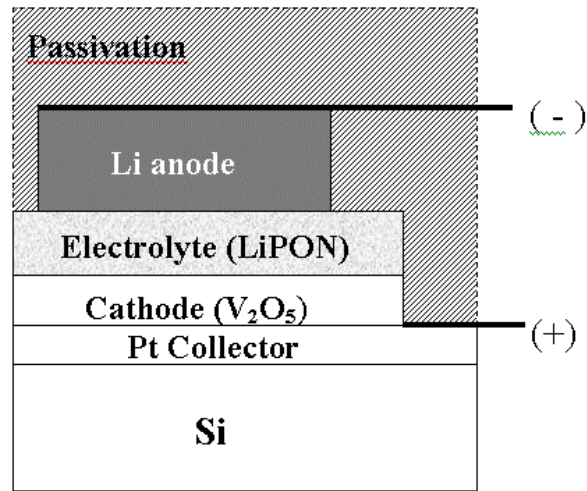


Figure 2. (a)

, (b) Li/LiPON/V<sub>2</sub>O<sub>5</sub>

가

SEM

(Current collector)

5  $\mu\text{m}$  ,

가

, rf (radio frequency)

, dc (direct current) , (e-beam evaporator),

(thermal evaporator), CVD (chemical vapor deposition), PLD (pulsed laser deposition),

Sol-gel

가 가

**A. (Current collector)**

Au, Pt, Cu, Ru, Cr , ITO

Pt

Pt

가

**B. (Cathode material)**

가

, , ,

가

가

$V_2O_5$ ,  $LiCoO_2$ ,  $LiMn_2O_4$ ,  $LiNiO_2$ ,

1 .[1]

Table 1.

	Amorphous $V_2O_5$	$LiNiO_2$	$LiCoO_2$	$LiMnO_2$
<b>Theoretical capacity (mAh/g)</b>	420	192	137	148
<b>Structure</b>	Amorphous	Layered structure	Layered structure	Spinel structure
<b>Characteristics</b>	Easy synthesis, Low cost, No annealing process	Low thermal stability, Difficulty of synthesis, Need to annealing	High cost, Toxic material, Need to annealing	Low cost, Stability in atmosphere, Need to annealing

$TiS_2$ ,  $MoS_2$

가

1.5 -2V

가

evapoation

가

$LiCoO_2$

$LiMn_2O_4$

3V

,  $LiCoO_2$   $LiMn_2O_4$  가

가

700°C

on-chip 가

가

가가

가

가

가

$V_2O_5$

[8]

$V_2O_5$  3V

가

가 가

가

가

가

가

$V_2O_5$

2

*in-situ*

가

[9,10]

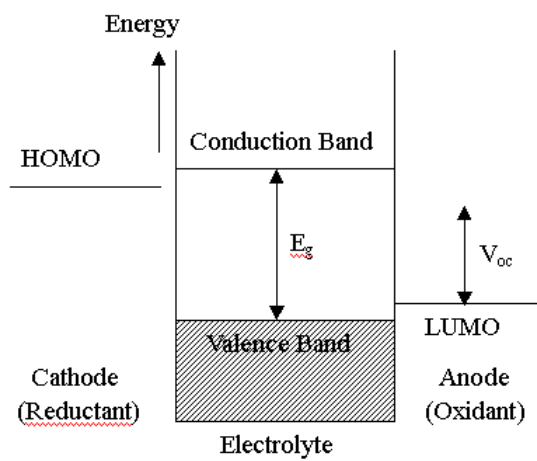


Figure 3.

band

**B. (Solid electrolyte)**

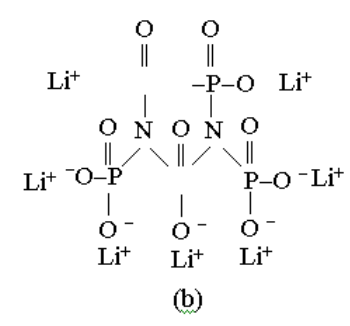
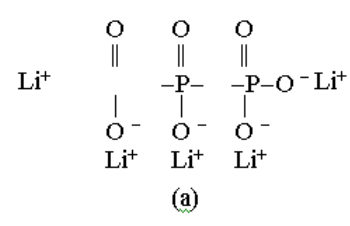
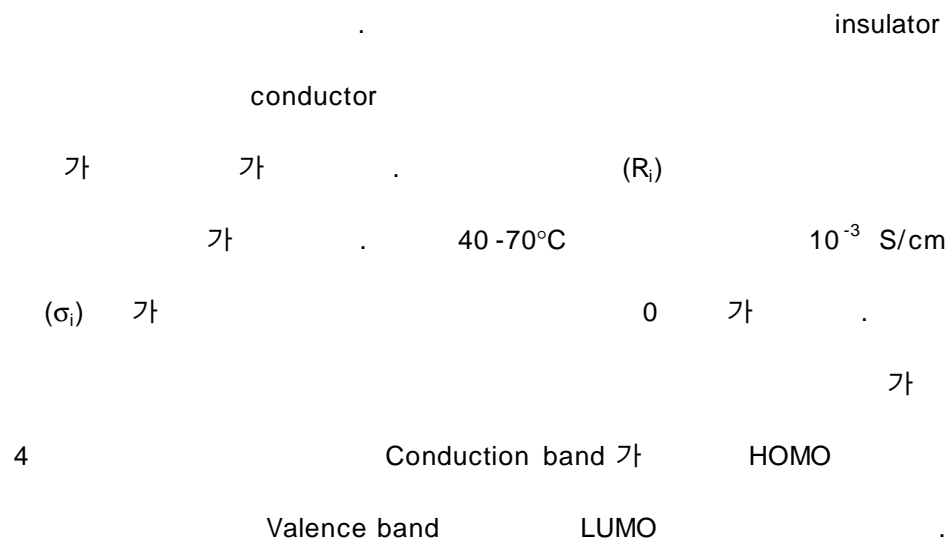
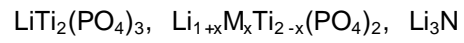


Figure 4. LiPON (a) LiPO<sub>3</sub> (b) >N- cross-linking

10<sup>-2</sup>~10<sup>-3</sup> S/cm

1μm





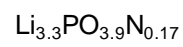
가

가

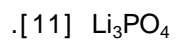
가

ORNL J.

Bates



가 가



LiPON

$2 \times 10^{-6}$  S/cm

가

5.5V

가

가

2

LiPON

LiPON

가 가



가

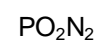
5

N

가



O



=N-

-N<

cross-linking

가

가

C.

(anode)

가

가 , 가  
가 ( 0.54 g/cm<sup>3</sup>) 가 , (-3.045  
V<sub>SHE</sub>), (3.86 Ah/g) 가 가

(Tin -oxide) Li  
2  
4 가  
가 . 1997 Fujifilm CellTec Com  
(Trademark STALION) , Tin -oxide  
. Fuji photo film com Idota group Tin -based amorphous  
oxide Li 가 , 가

Li  
가 가 .  
가 70%

가 ,  
가 .

II -2.

Li V<sub>2</sub>O<sub>5</sub>  
 가 , Li  
 가 . 5(a)가 V<sub>2</sub>O<sub>5</sub>  
 V<sub>2</sub>O<sub>5</sub> , LiPON Li ion Li<sup>+</sup> + e =>  
 Li .  
 Li LiPON LiPON .  
 V<sub>2</sub>O<sub>5</sub> Li  
 V<sub>2</sub>O<sub>5</sub> LiPON Li Li d  
 Li ( 5(b)).

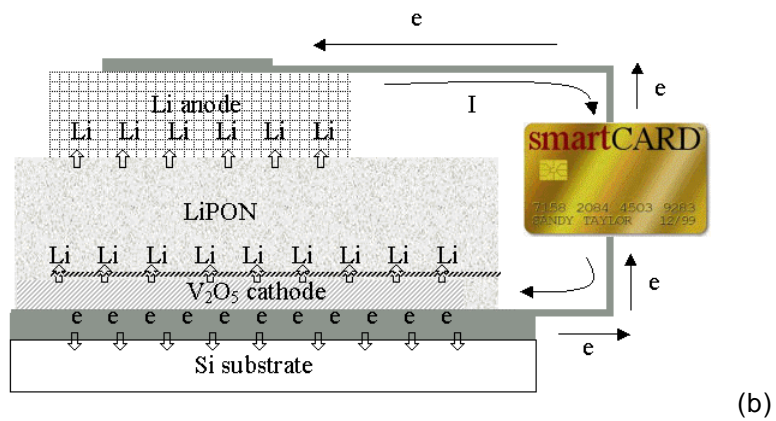
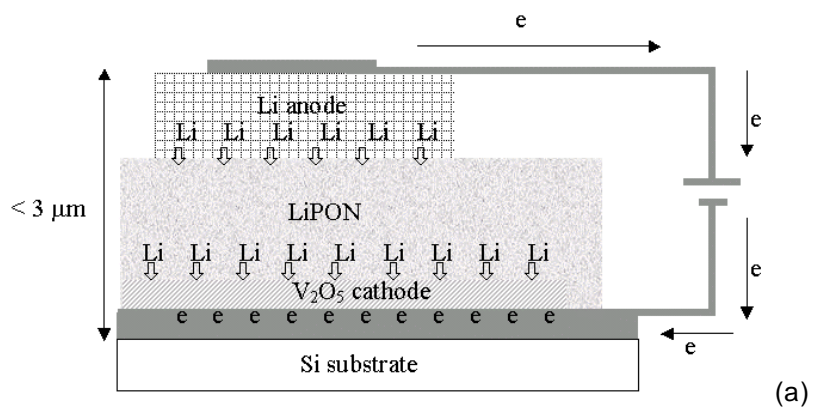


Figure 5. V<sub>2</sub>O<sub>5</sub> 가

(a) LiPON Li (b)

Li

, MEMS

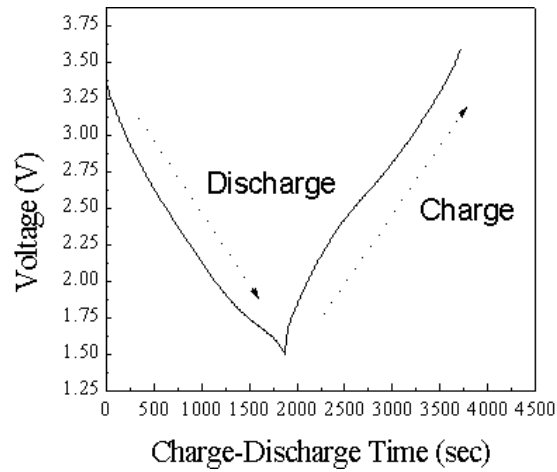


Figure 6.

III.

,  $\text{TiS}_2$ ,  $\text{V}_2\text{O}_5$ ,  $\text{LiCoO}_2$ , $\text{LiMn}_2\text{O}_4$ 

2

Table 2.

Cathode type	$\text{TiS}_2$	Amorphous $\text{V}_2\text{O}_5$	$\text{LiCoO}_2$	$\text{LiMn}_2\text{O}_4$
Laboratory	Eveready	KIST	ORNL	ORNL
Voltage[V]	2.5 -1.8	1.5 -3.6	3.8 -4.2	3.8 -4.1
Growing method	rf sputtering	dc sputtering	rf puttering	rf puttering
Capacity [ $\mu\text{Ah}/\text{cm}^2$ - $\mu\text{m}$ ]	75	120	60	30
Energy density [Wh/L]	500	700	800	500
Specific energy [Wh/kg]	225	420	125	190

Li

7

Li

가

plateau 가

가 cut-off

가 cut-off

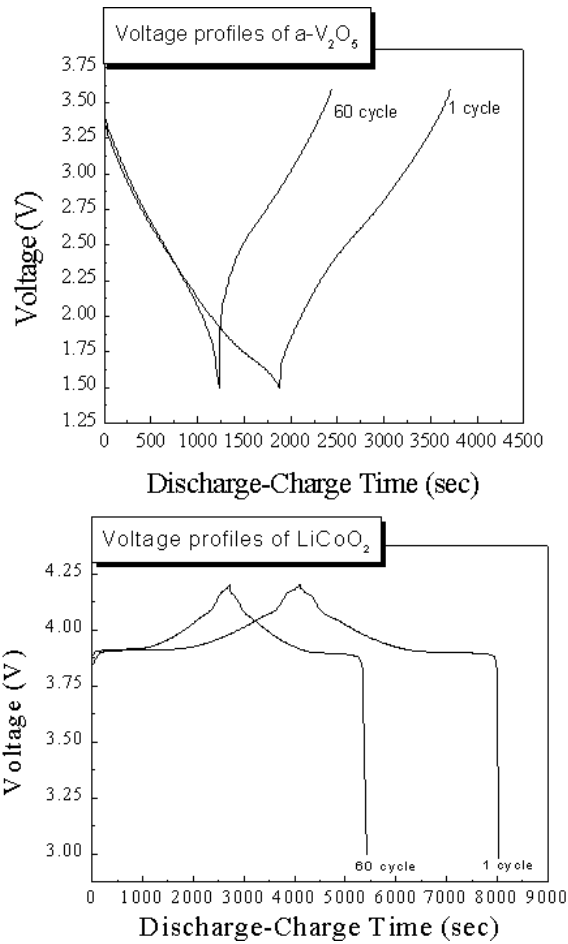


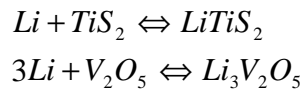
Figure 7.

(a)

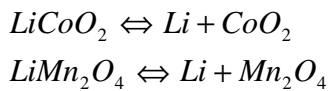
(V<sub>2</sub>O<sub>5</sub>), (b)

(LiCoO<sub>2</sub>)

7(a)  $V_2O_5$  - , -  
 .  $Li^+$   
 LiPON , LiPON  $V_2O_5$   $Li^+$   
 . 가  $Li^+$   $Li-V_2O_5$   
 .  $Li^+$  cut-off  
 .  $Li-TiS_2$   $Li$ -amorphous  $V_2O_5$  -  
 ,  
 - . -  
 .



$LiCoO_2$ ( )  $LiMn_2O_4$ ( )  $Li-TiS_2$   
 $Li$ -amorphous  $V_2O_5$   
 . 3-4V Open  
 circuit voltage .  $Li$   
 가 . 가 -  
 - 7(b) .



-

가

Pt      Cu      V<sub>2</sub>O<sub>5</sub>  
8      Pt  
V<sub>2</sub>O<sub>5</sub>      .[10]

in-situ process

.[9]

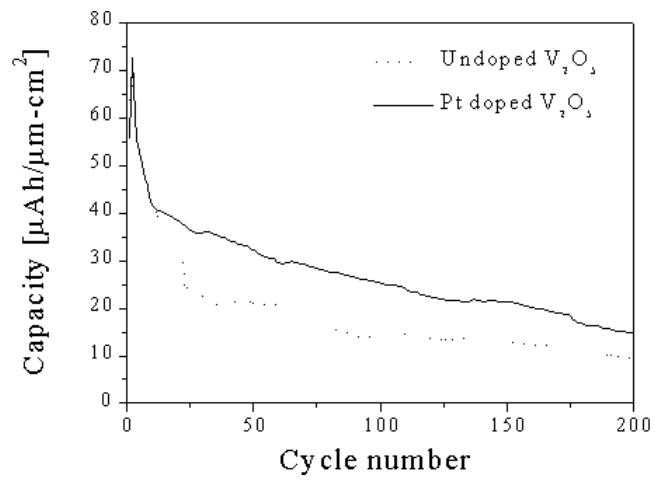


Figure 8. Pt

가

IV.

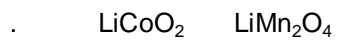
가

가



aging effect

가



가

가

가

RTA(rapid thermal annealing)

가



ORNL

Parylene

가

V.

가

가

가

9

PCS

가

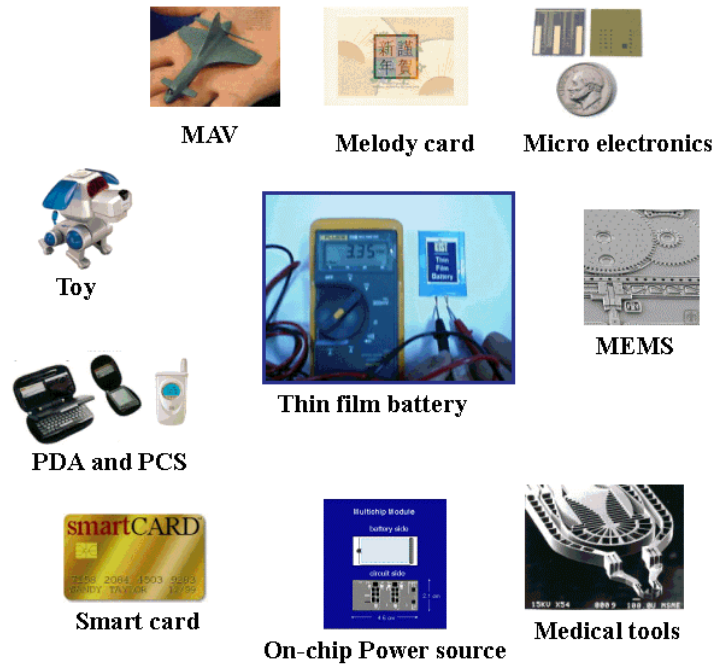


Figure 9.

3 가 가 .[12]

(MEMS: microelectronicmechanical system), on-chip power source

Table 3.

	Sensor Pill	Hazard card	Security card
Voltage [V]	3	3	3
Load (Discharge) [ $\mu$ A]	3	10.3	10
Cycle life			
Discharge time	4	24	24
Number of cycle	1000	1000	1000
Battery life [year]	3	3	3
Capacity[ $\mu$ Ah/cycle]	12	248	240

Dimensions [Area, cm <sup>2</sup> ]	0.2	8	9
Impedance [kΩ -cm <sup>2</sup> ]	6.5	16	90
Current density [μA/ cm <sup>2</sup> ]	15.3	1.3	1.1
Battery Loading [μAh/ cm <sup>2</sup> ]	61	31	27

on -chip

가

가

PDA

가

가

가

MAV (micro air

vehicle)

가 가

가

가

가

2007

, 2008

on -chip

power source

VI.

가

가 가  
가 가  
가  
가 가  
가 가

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