DRAWINGS

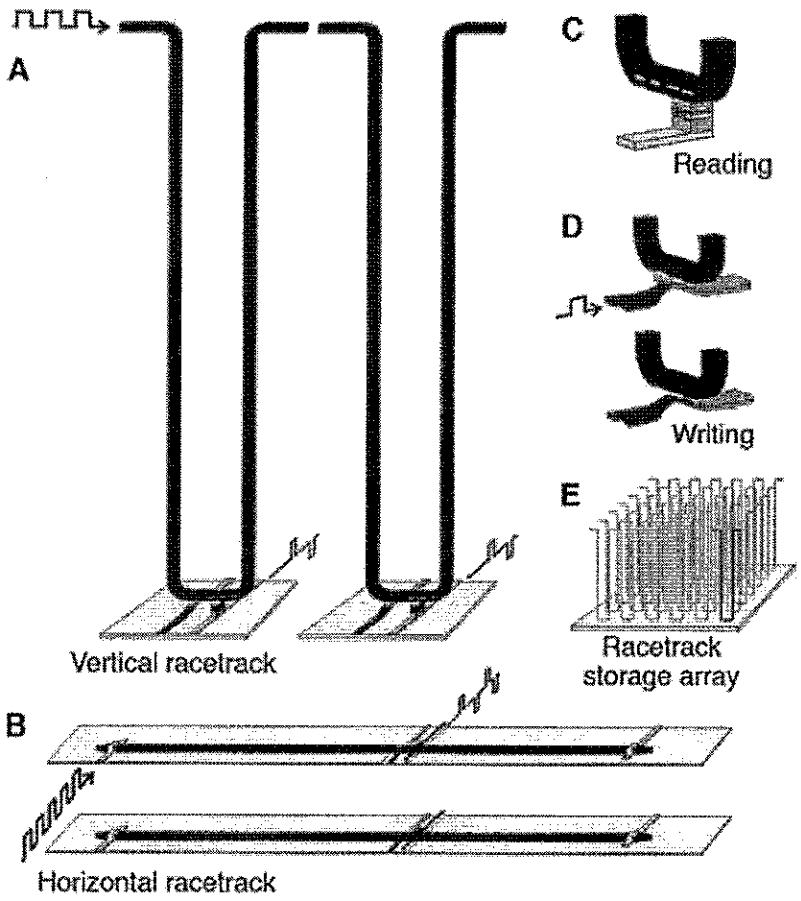

Figure 1 (prior art)

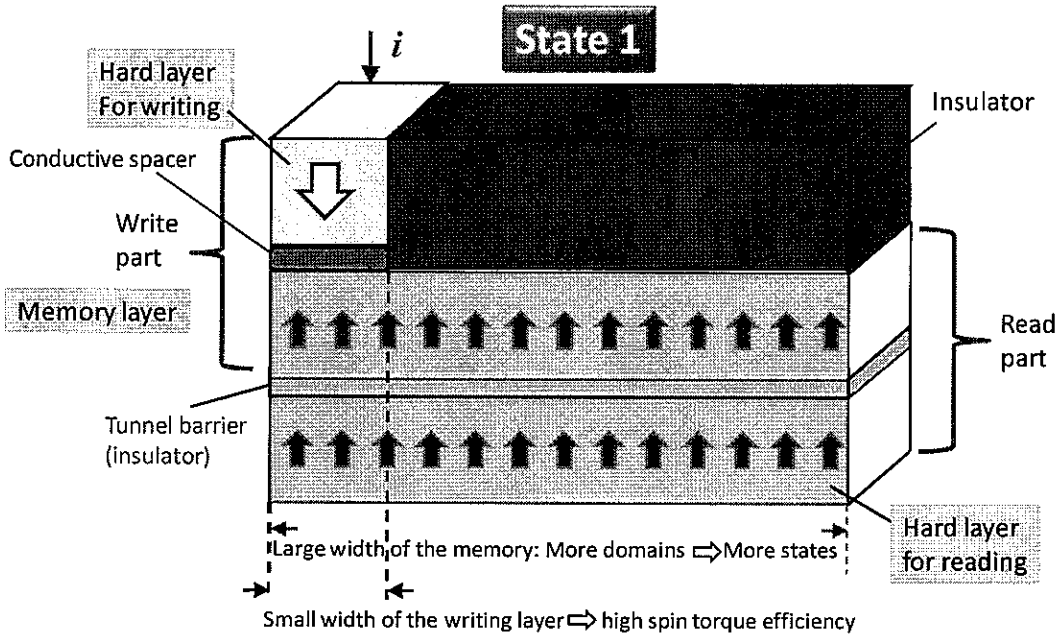
State 1
i
Hard layer
For writing
Insulator
Conductive spacer
Write
part
Memory layer
Read
part
Tunnel barrier
(insulator)
Hard layer
for reading
Large width of the memory: More domains ⇨More states
Small width of the writing layer⇨ high spin torque efficiency

Figure 2

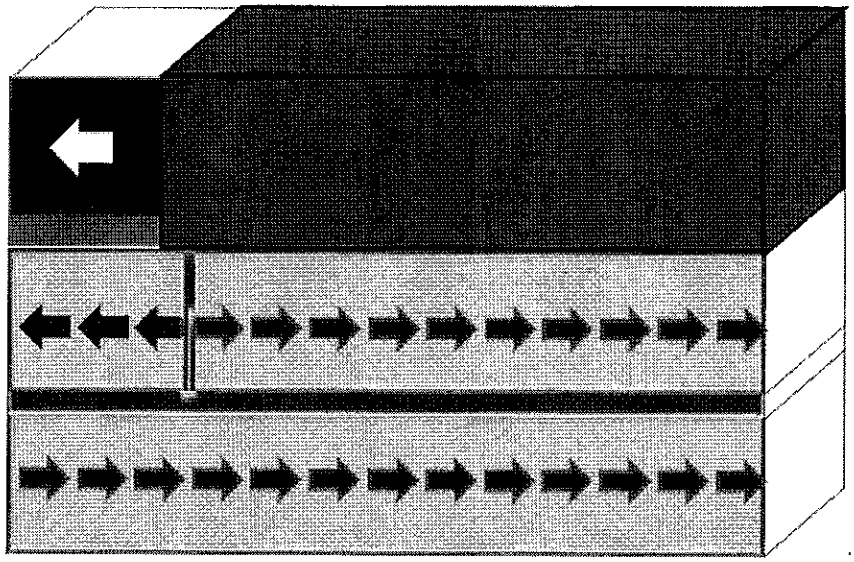

Figure 3

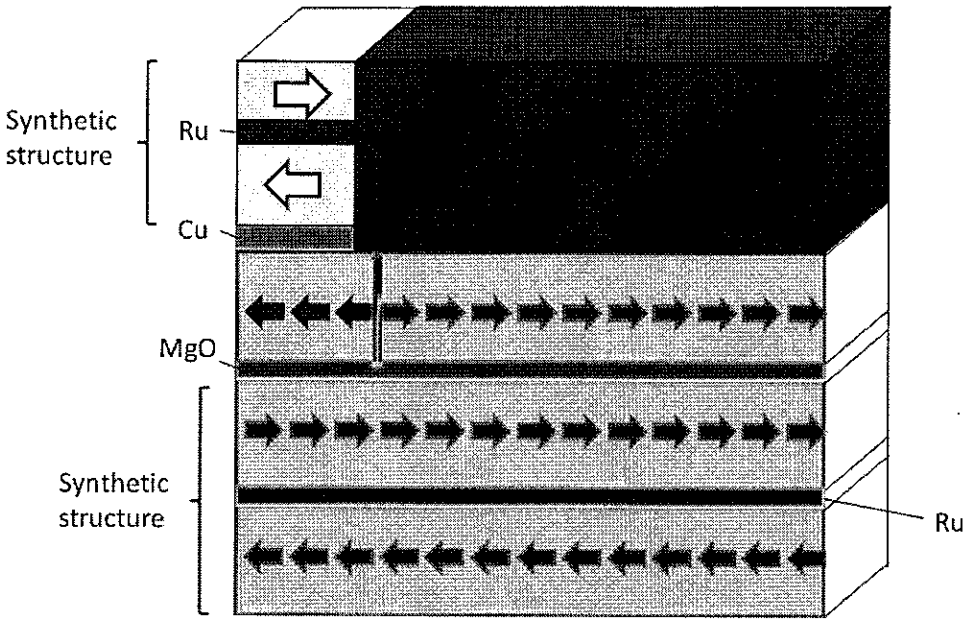

Figure 4

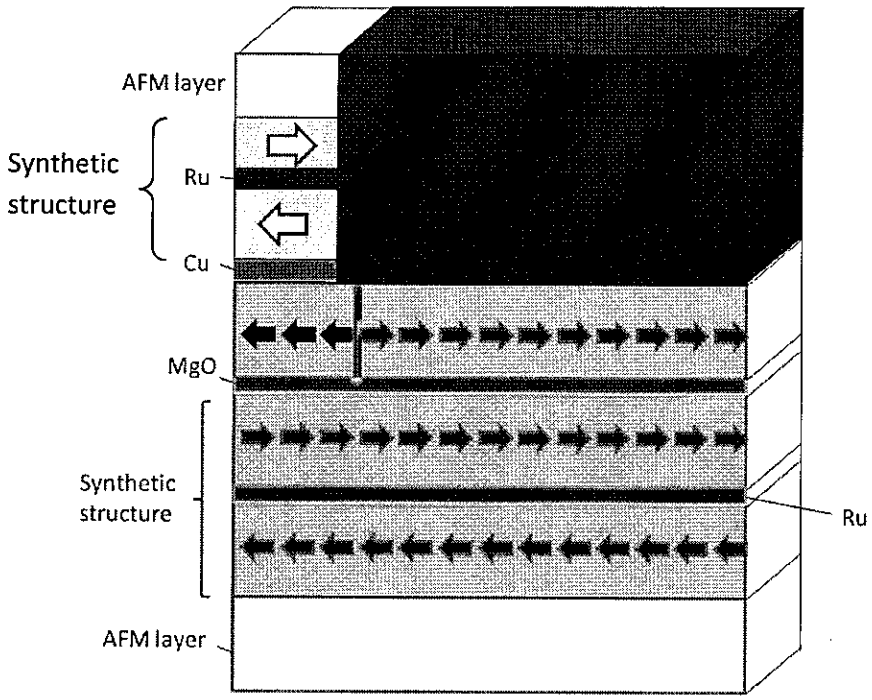
AFM layer
Synthetic structure
Ru
Cu
MgO
Synthetic structure
Ru
AFM layer

Figure 5

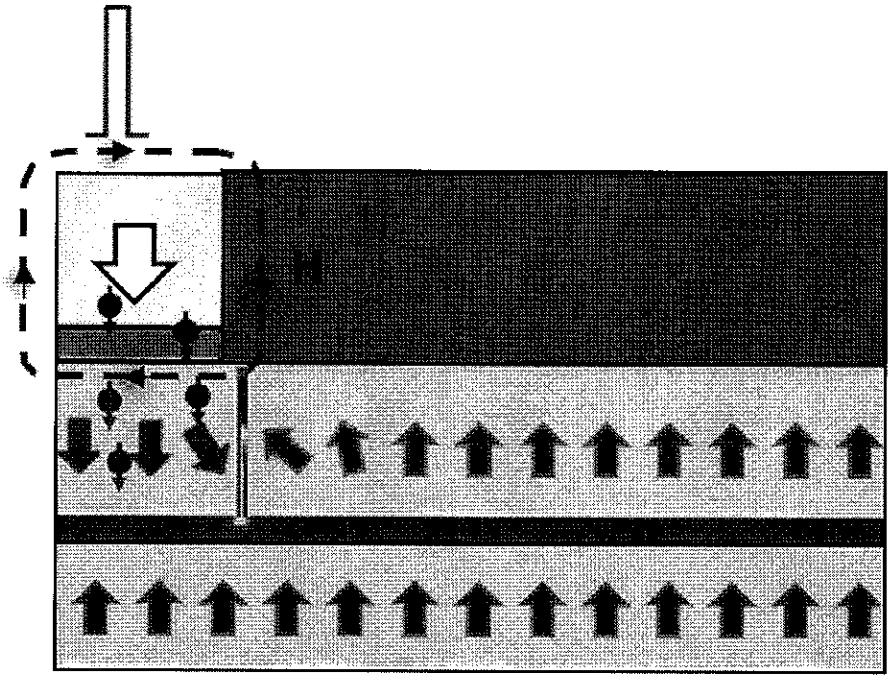

Figure 6a

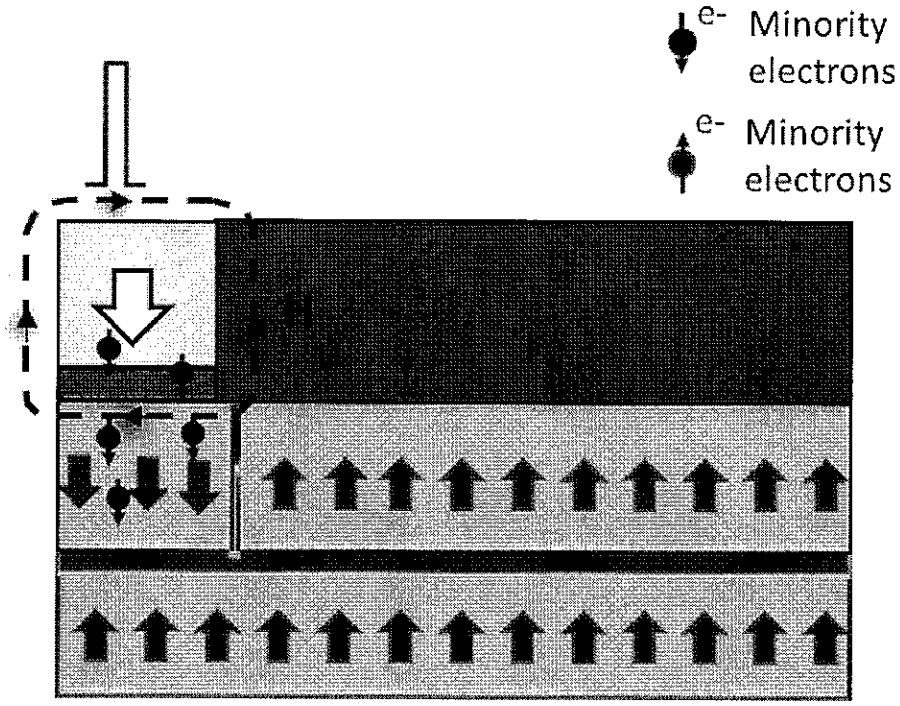

Figure 6b

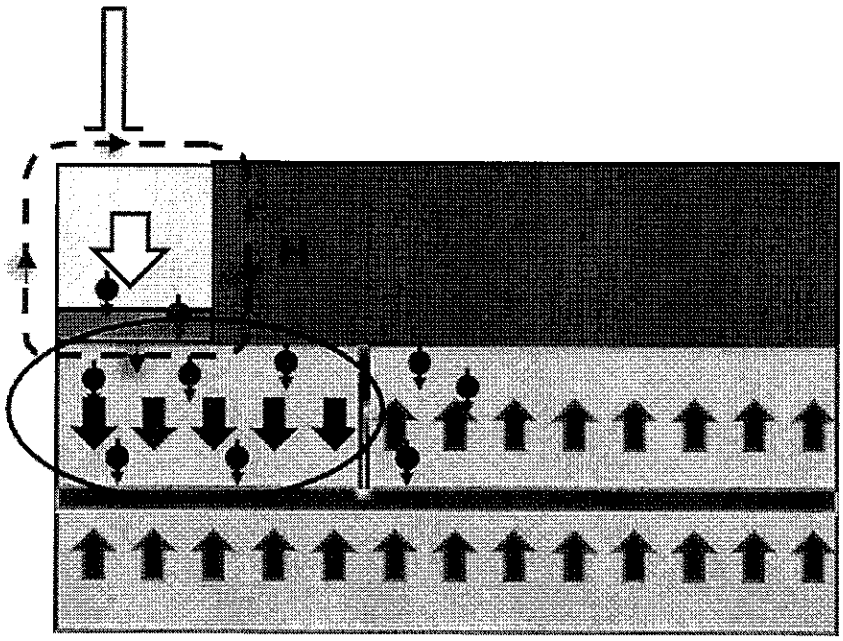

Figure 7

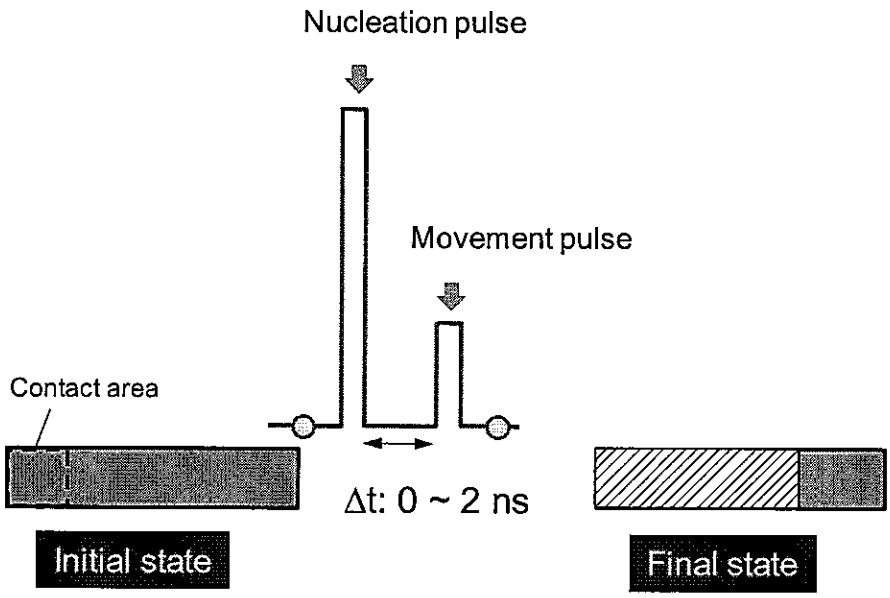
Nucleation pulse
Movement pulse
Contact area
Δt: 0 ~ 2 ns
Initial state
Final state

Figure 8

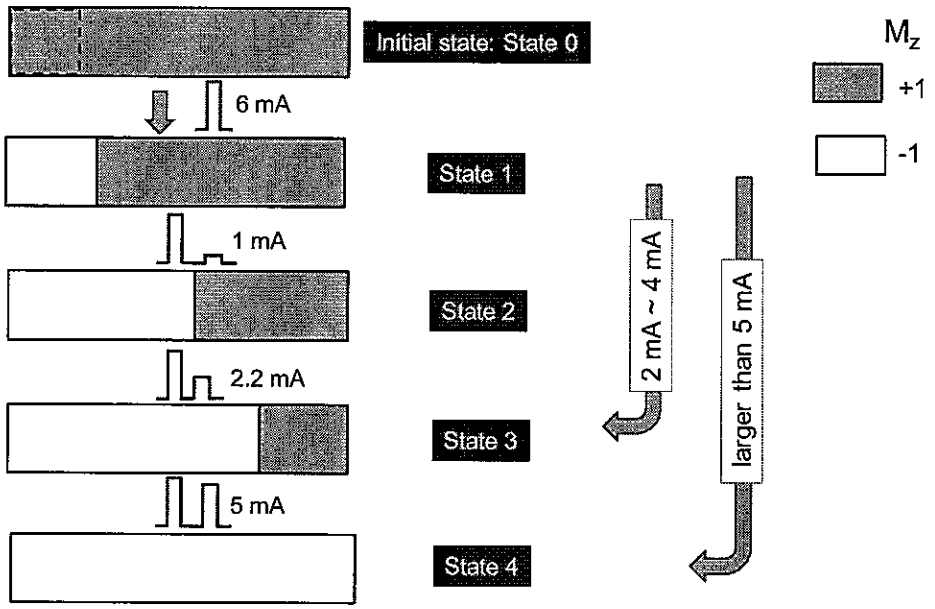
Initial state: State 0
6 mA
State 1
1 mA
State 2
2.2 mA
State 3
5 mA
State 4
2 mA ~ 4 mA
larger than 5 mA
M_z
+1
-1

Figure 9

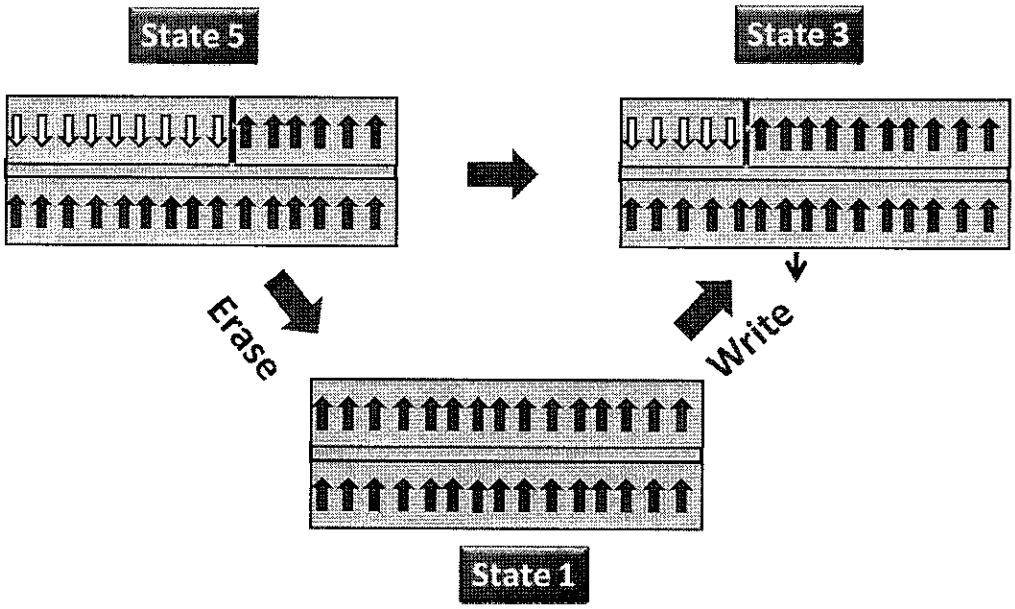

Figure 10

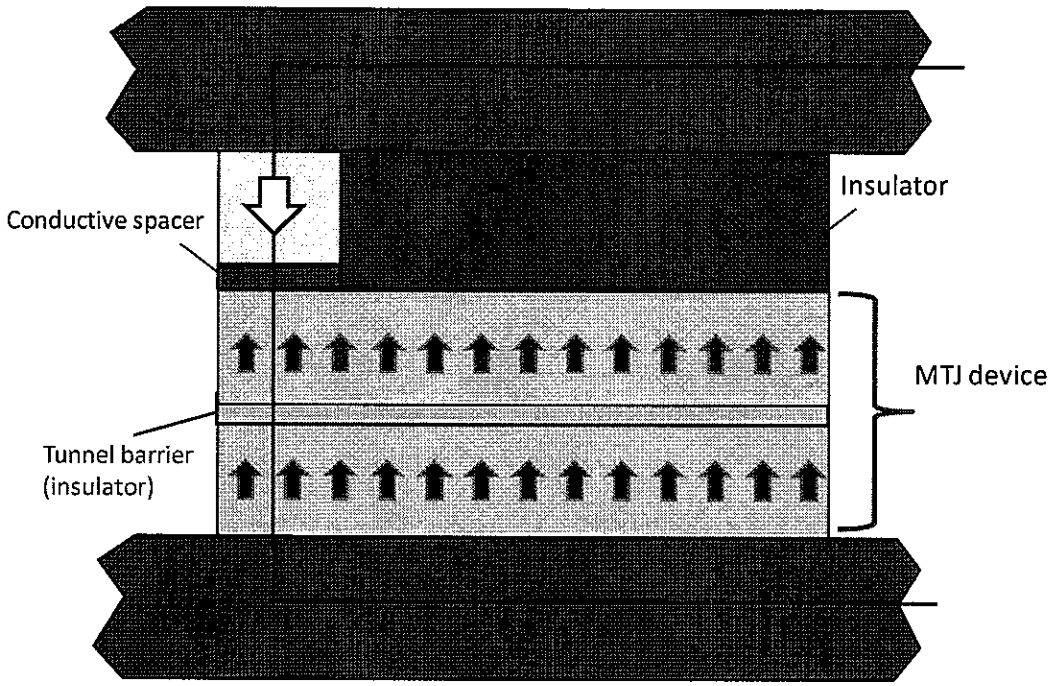
Conductive spacer
Insulator
MTJ device
Tunnel barrier
(insulator)

Figure 11

Data	State Number	Resistance Level
0 0 0	State 1	R_1
0 0 1	State 2	R_2
0 1 0	State 3	R_3
0 1 1	State 4	R_4
1 0 0	State 5	R_5
1 0 1	State 6	R_6
1 1 0	State 7	R_7
1 1 1	State 8	R_8

Table 1

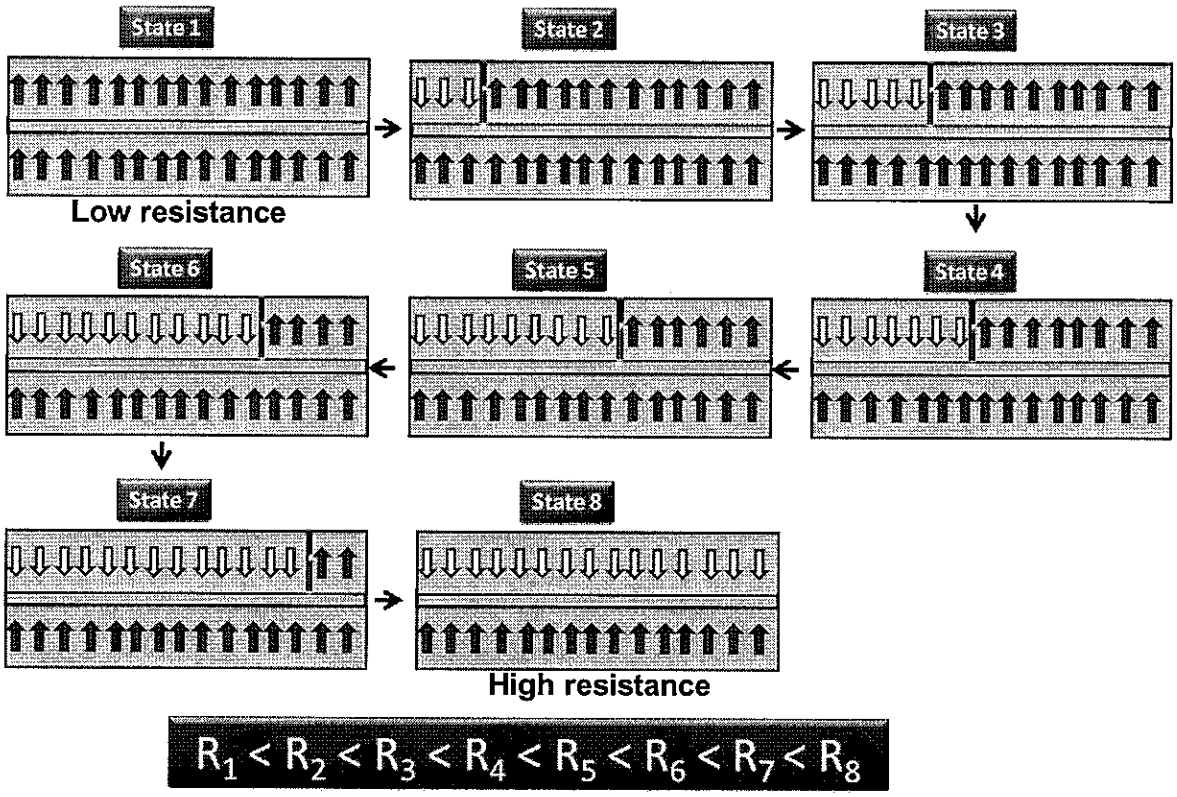
State 1
State 2
State 3
Low resistance
State 6
State 5
State 4
State 7
State 8
High resistance
$R_1 < R_2 < R_3 < R_4 < R_5 < R_6 < R_7 < R_8$

Figure 12

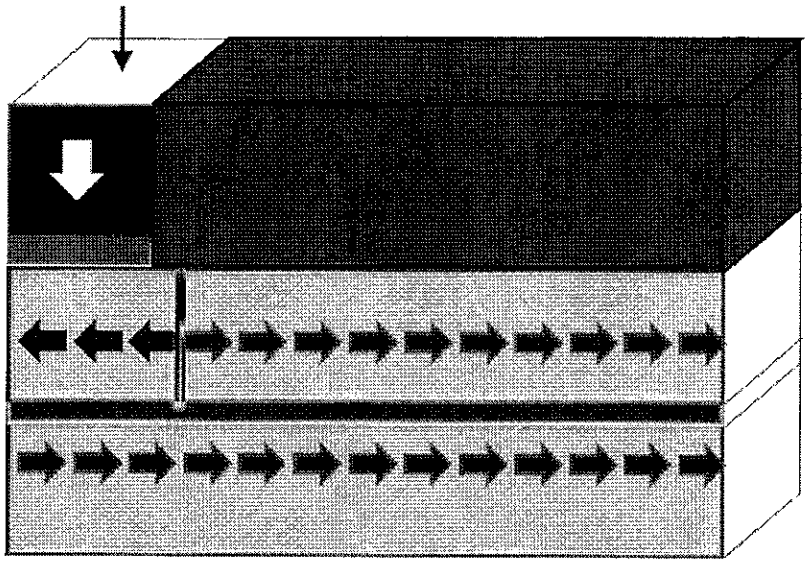

Figure 13

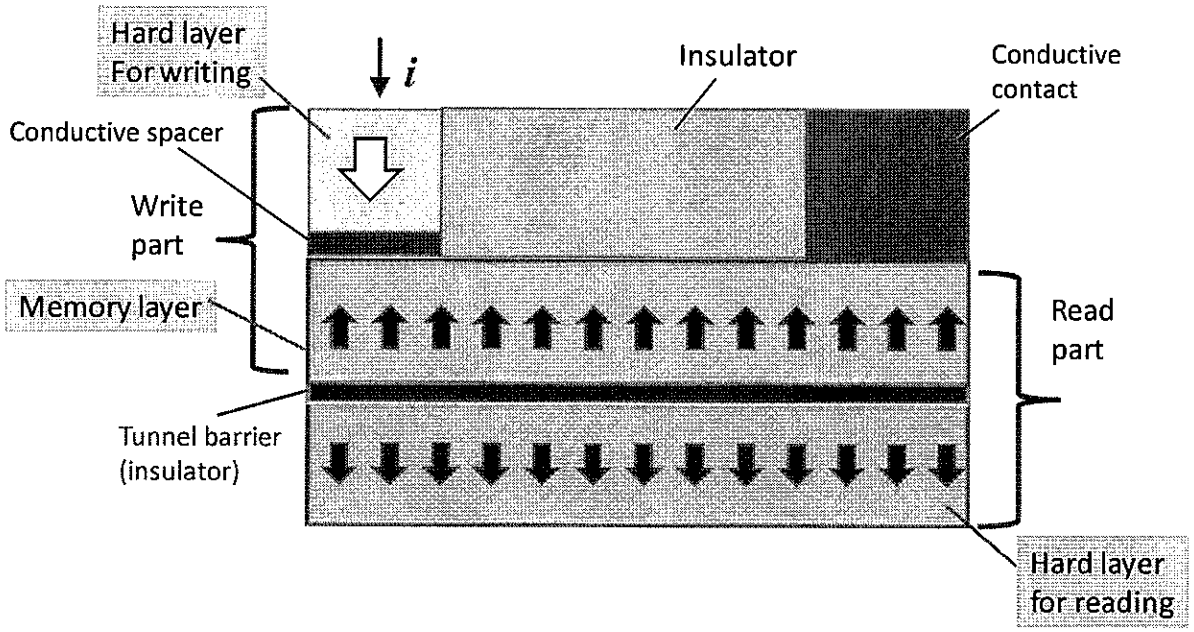
Hard layer
For writing
i
Insulator
Conductive
contact
Conductive spacer
Write
part
Memory layer
Read
part
Tunnel barrier
(insulator)
Hard layer
for reading

Figure 14