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Ovonic Unified Memory

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Abstract- Till now the semiconductor devices formed the basis for the memory. Ranging from a small device like calculator to the huge devices like computers semiconductor devices was used for data storage. The data stored in these devices was in the binary format. Since the semiconductor devices has reached its limit thus the new memory devices like Phase change memory (PCM), also called as Ovonic Unified Memory (OUM) was developed. Along with OUM there were various other memory devices like FRAM, MRAM, and Polymer Memory which were also developed. But among all these OUM was found to be the most promising one and thus is being used in some devices. Conventially the data storage was in the charge form which is now in the charge form in the new memory technologies.

Keywords- Phase change memory, Ovonic unified memory, set/reset, amorphous state, crystalline state

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INTRODUCTION

For the temporary or permanent storage of data in the computer or in other electronic devices a physical device called 'memory' is used to store the programs or data. The term 'memory' is often related with the semiconductor devices consisting of transistors along with other electronic devices to store the data. In the semiconductor memory, a bit of data is stored in a tiny circuit called *cell.* These cells are formed by group of electronic component consisting mainly of the transistor and capacitor. Thus in order to store the large amount of data large number of cells required gave rise to many other problems. For example Intel's 10-core Xeon Westmere-EX has 10 millions of transistor. Transistor count is the most common technique to measure the complexity of an integrated circuit. According to Moore's law the transistor count of the integrated circuit doubles in every two year. Doubling the number of transistors and reducing the cell size increases the speed of the memory or processors.

Increasing the number of transistors in cells, and by reducing the chip size gave rise to various problems like heat dissipation, cell size, design complexity and many more. Semiconductor memory has the advantage of random storage and access, thus data could be efficiently stored and can be accessed easily in a random order.

Among the various new memory technologies OUM is found to be the most promising one. OUM is a non-volatile random access memory. OUM uses the change in the resistance of a material to store the data. This technique is also used in the CD, DVD etc to store the data. The material used is chalcogenide alloy. The alloy consists of the Group VI elements of the periodic table. Change in the resistance of a material is done by heating the material to maintain it either in the amorphous or crystalline state.

Amorphous state is obtained by heating the material above its melting point and then by cooling it suddenly while the crystalline state is obtained by heating the material about its melting point and then by slowly cooling it. Amorphous state represents the RESET state while the crystalline state represents the SET state.

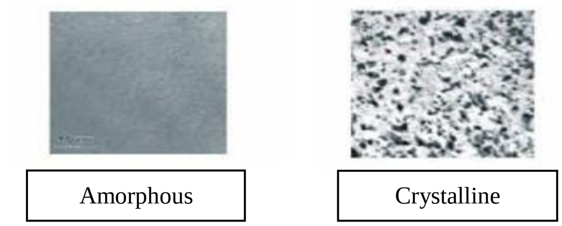

Fig1. Amorphous and crystalline state

OVONIC UNIFIED MEMORY

In the year 1960, Stanford. R. Ovshinsky, of Energy Conservation Devices explored the properties of the chalcogenide alloy. Thus the name OVONIC was derived from OV from Ovshinsky and NIC from the latter part of ELCTRONIC.

OUM generally uses the thin film alloy of $Ge_2Sb_2Te_5$ (GST) also called as chalcogenide alloy to store the data. The melting point of chalcogenide alloy is about 600^0C and the crystallization temperature is about 100-150^0C. The architecture of OUM is as shown in fig 2.

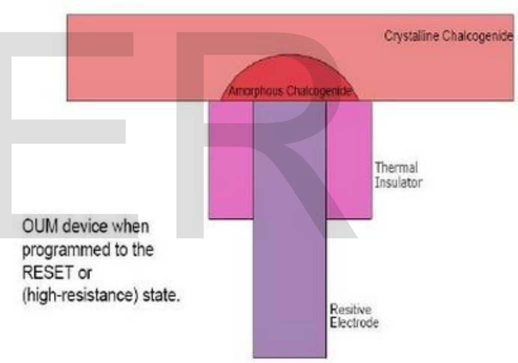

Fig2. Architecture of OUM

The cell of OUM consists of resistive heater electrode, alloy and an insulator surrounded by the alloy as shown to prevent the data loss due to heat. The bottom of the cell is connected with diode or CMOS. Unlike convential memory technologies the data storage in the emerging technologies is not in the form of charges and the reading of data is done by measuring the resistance of the alloy. The amorphous state having high resistance (>100k) indicate binary 1 while the crystalline state having low resistance(~ 1k) indicates the binary 0.

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V-I Characteristics

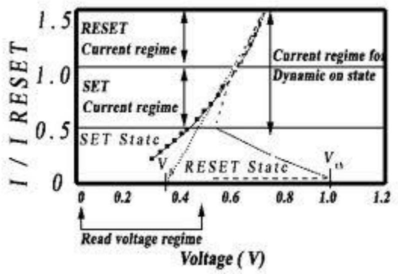

Fig3. V-I characteristics of OUM

The V-I characteristics of OUM is as shown in Fig3. The low voltage region indicates the read region i.e. the reading operation is performed at low voltages (<0.4 V) while in order to write the data the voltage must be approximately greater than V_{th}. Thus in order to program the device the voltages must be applied such that the device in driven into the "Dynamic On State."

The reciprocal of the V-I curve in the dynamic in state gives the device series resistance.

CONCLUSION

Unlike conventional flash memory OUM can be randomly addressed.OUM requires less IC manufacturing steps and thus resulting in fewer defects, reduced cycle time and greater manufacturing flexibility. It has direct application in devices using solid state memory e.g. computer, cell phone, PDA and so on.

ADVANTAGES

- Non-Volatile in nature
- Nearly ideal memory characteristics
- Low read/write power
- High endurance
- Highly scalable
- High temperature resistance
- Long data retention
- Can be easily integrated with CMOS
- Less costly
- Simple manufacturing process
- Unlike DRAM no need to refresh the cell regularly

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