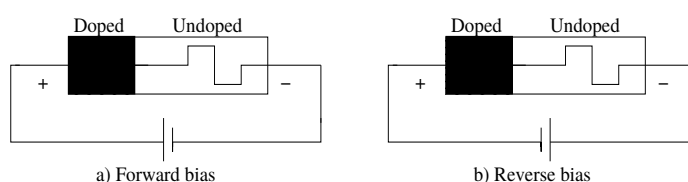Figure 76: Memristor

Figure 77: Forward and reverse bias

Memristive device

In TiO_2 based device, resistance depends on the direction of current flow.

Polarity and symbol of memristor are shown Figure 76.

Here (Figure 76(a)), two regions - a region of TiO_{2-x} (e.g. Ti_4O_7), called dopped region, and
a region of pure TiO_2 (undopped) are packed between two platinum electrodes.

The dopped region with TiO_{2-x} is having free oxygen vacancies.

These are positively charged and characterize dopped region as the low resistance region.

On the other hand, the undopped (pure TiO_2) region is of high resistance.

R_{off} (undopped) $>>$ R_{on} (dopped).

If a memrister device is forward biased (Figure 77(a)),
the positively charged oxygen vacancies are repelled
-that is, low resistance region (dopped region) is expanded.

It results in decrease in overall resistance of the device.

On the other hand, when the device is reverse biased ((Figure 77(b))
TiO_2 (undopped) region is expanded
therefore, the overall resistance of the device is increased.

The fact is a memristor has, therefore, two states high resistance and low resistance.

However, the property of this oxygen vacancies is unique in the sense that if voltage is withdrawn
oxygen vacancies remain in the position that they were the last point in time.

If applied voltage is removed, it will stay at its resistance state and exhibit the behavior of memory".

Low (high) resistance corresponds to the logic 1 (0) state.

If an applied voltage is smaller (larger) than a threshold voltage V_{close} (V_{open})

the state of resistance will change from high to low (low to high).

Otherwise, the memristor stays at the present state.

Memristive Crossbar Memory

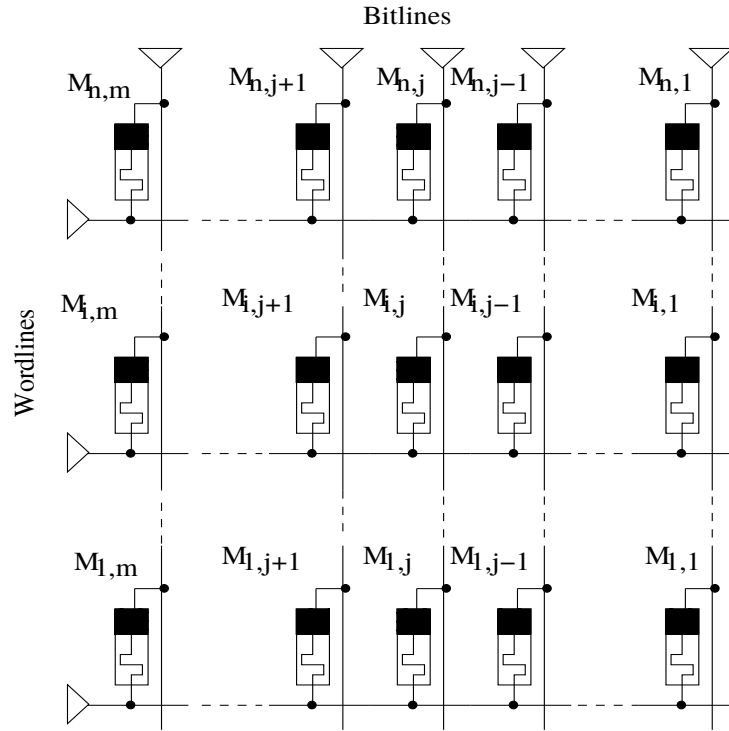Figure 80 shows the general structure of memristive crossbar memory.

Figure 80: Memristor crossbar

Write operation in the memristive memory

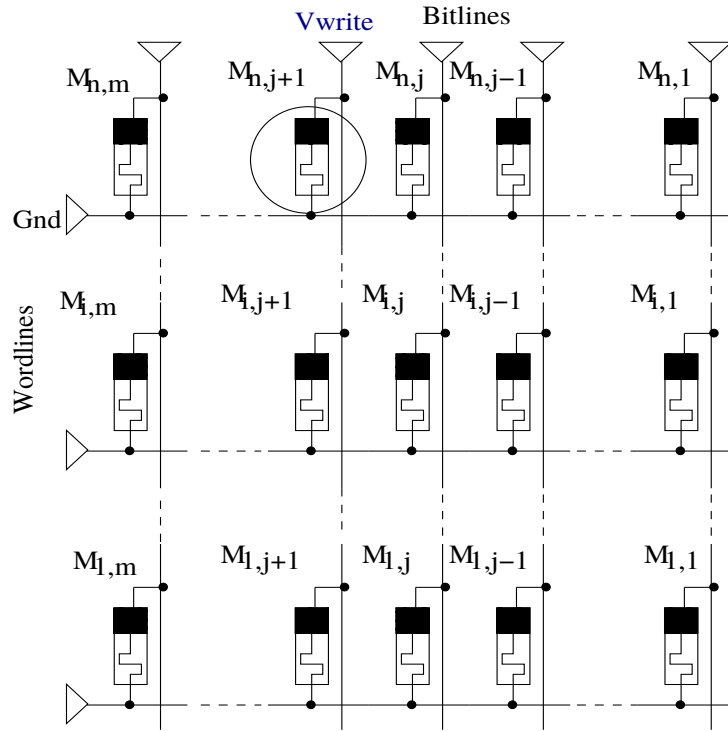Figure 81 describes the write operation.

Figure 81: Write to memristive memory

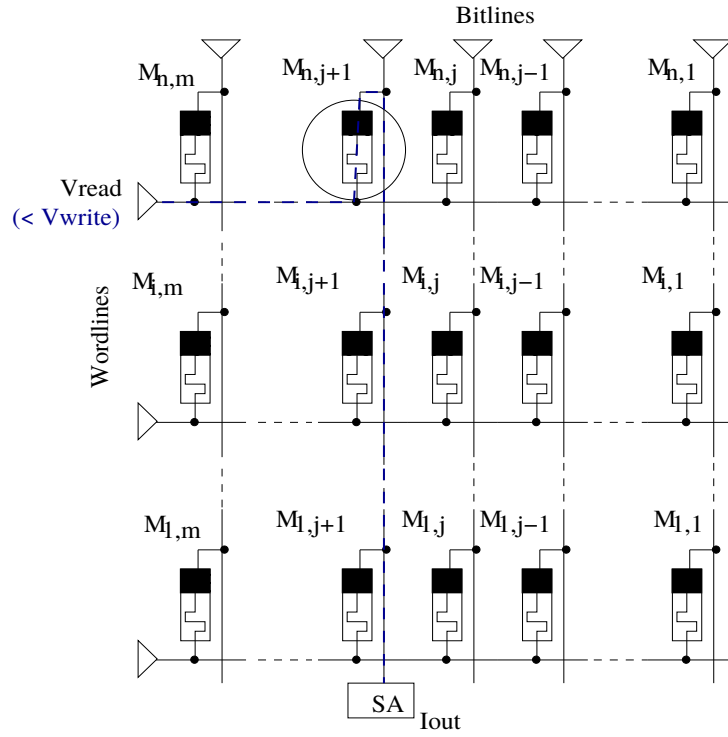**Read operation in memristive memory**

Figure 82 describes the read operation.

Figure 82: Read from memristive memory