

# From Storage to Screens: Key Materials

## Learning Outcomes

- ❖ About Display Systems and electronics memory devices
- ❖ About Organic memory devices
- ❖ Properties and function of element retardants in computers
- ❖ Key concepts, components and functioning of both memory systems and display technologies
- ❖ Explore emerging display
- ❖ Applications related to memory and display systems
- ❖ Innovation and Future Opportunities
- ❖ Technological advancements shaping the world

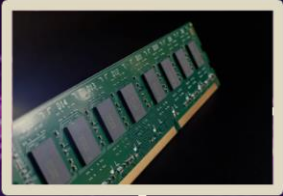


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# MEMORY DEVICES



## Volatile Memory

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Temporarily stores data while a device is in use, providing fast access to support active processes. However, data is lost when power is turned off.



## Non-Volatile Memory

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Retains data even without power, making it ideal for long-term storage. NVM devices are commonly used for storage in applications that require data persistence, like in computers, smartphones, and embedded systems.



# KEY TERMS



```
graph TD;
  KT[KEY TERMS] --- A[A CAPACITY];
  KT --- B[B ACCESS TIME];
  KT --- C[C READ/WRITE OPERATIONS];
```

A

CAPACITY

B

ACCESS TIME

C

READ/WRITE OPERATIONS

## CAPACITY

KILO BYTES  
MEGA BYTES  
GIGA BYTES  
TERA BYTES

## ACCESS TIME

Access time is the duration between the memory request and the completion of data transfer to or from memory.

## READ/WRITE OPERATIONS

Determines if data can be altered (read-only or read-write).



# Types of Electronic Memory Devices

## Transistor-Type Memory

- Description: Uses transistors as the primary element to store data.
- Example: DRAM (Dynamic RAM) and SRAM (Static RAM).
- Functionality:
  - DRAM: Uses one transistor and one capacitor per cell, requires frequent refreshing.
  - SRAM: Uses multiple transistors per cell (typically 6), providing faster access without the need for refreshing.

Applications: Fast-access memory in computers (e.g., cache memory).

## Resistor-Type Memory

- Description: Utilizes resistive materials to store data by changing resistance levels.
- Example: RRAM (Resistive RAM).
- Functionality: Alters the resistance of a material to represent binary states (0 and 1).
- Applications: Emerging memory technologies; potential for high-density storage in future devices.

## Charge-Transfer Type Memory

- Description: Stores data by transferring electrical charges.
- Example: Flash Memory.
- Functionality:
  - Stores charges in floating-gate transistors; data is retained even without power (non-volatile).
- Applications: USB drives, SSDs, and memory cards due to durability and non-volatility.



# Types of Organic Memory Devices

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graph TD; A[Types of Organic Memory Devices] --> B[Organic Resistive Memory]; A --> C[Organic Ferroelectric Memory]; A --> D[Organic Transistor Memory]; A --> E[Organic Photonic Memory];
```

## Organic Resistive Memory

**Description:** Uses organic materials with variable resistance to store data.

**Mechanism:** Data is stored by switching between high and low resistance states, representing binary 0s and 1s.

**Applications:** Flexible electronics and wearable technology due to lightweight, flexible properties.

## Organic Ferroelectric Memory

**Description:** Employs organic ferroelectric polymers to retain data even without power.

**Mechanism:** Data is stored by aligning electric dipoles within the polymer; can switch polarization states for data retention.

**Applications:** Low-power memory in portable devices, as it provides non-volatile data storage.

## Organic Transistor Memory

**Description:** Utilizes organic field-effect transistors to store charge and represent data.

**Mechanism:** Data is stored by changing the charge in the transistors channel, allowing it to "remember" states.

**Applications:** Emerging in flexible displays and low-cost memory solutions.

## Organic Photonic Memory

**Description:** Uses light-sensitive organic materials to store information.

**Mechanism:** Data is stored by changing the optical properties of the material in response to light.

**Applications:** Potential use in optical data storage and bio-integrated devices.



# DISPLAY SYSTEMS



Display systems are electronic visual output devices that show text, images, and videos. They are essential for user interfaces in computers, TVs, mobile devices, and more.

## OLED

**Description:** Uses organic compounds that emit light when electrified, eliminating the need for a backlight.

**Advantages:** High contrast ratio, deep blacks, excellent color accuracy, and flexibility.

**Applications:** High-end TVs, smartphones, and wearables.

## LED

**Description:** LCD screens with LED backlighting, which enhances brightness and energy efficiency.

**Advantages:** Better color control, brightness compared to traditional LCDs; widely available and affordable.

**Applications:** Televisions, monitors, laptops, and mobile devices.

## Micro-LED

**Description:** Composed of microscopic LEDs that can emit light independently, creating vibrant, precise colors without backlighting.

**Advantages:** High brightness, low power consumption, excellent durability; combines the best features of LED and OLED.

**Applications:** Emerging in high-resolution TVs, AR/VR headsets, and advanced digital displays.



# Photoactive and Electroactive Materials

## Photoactive Materials

- **Definition:** Materials that respond to light by generating a physical or chemical change.
- **Mechanism:** Absorb photons (light) and convert them into electrical charge or other forms of energy.
- **Examples:**
  - Photovoltaic Materials: Used in solar cells (e.g., silicon, organic photovoltaics).
  - Photodetectors: Materials that detect light (e.g., photodiodes).
- **Applications:** Solar energy conversion, light sensors, and imaging devices.

## Electroactive Materials

- **Definition:** Materials that undergo a physical or chemical change when exposed to an electric field or current.
- **Mechanism:** Respond to electrical stimuli by changing shape, conductivity, or other properties.
- **Examples:**
  - Piezoelectric Materials: Generate electric charge when stressed (e.g., quartz).
  - Conductive Polymers: Alter conductivity under electrical signals (e.g., polypyrrole).
- **Applications:** Actuators, sensors, energy storage devices, and artificial muscles.



# UNDERSTANDING LCDS

I am an LCD

## Disadvantages

- Limited Viewing Angles
- Slower Response Times
- Backlight Bleed
- Lower Contrast Ratios
- Fragility
- Power Consumption

- **Definition:** An LCD is a flat-panel display technology that uses liquid crystals to modulate light, creating images in electronic devices.
- **Structure:** Consists of layers – a backlight, polarizing filters, liquid crystal layer, and color filters.
- **Working Principle** Liquid crystals align to allow or block light when an electric current is applied. The light from the backlight passes through, creating images when controlled at each pixel.
- **Advantages:** Energy-efficient, slim design, high resolution, and suitable for portable devices (phones, laptops, TVs).
- **Common Uses:** Smartphones, computer monitors, TVs, calculators, and digital clocks.



# Microsoft HoloLens

**Introduction :** Microsoft HoloLens is a type of augmented reality (AR) headset that overlays digital content onto the real world, letting you interact with both simultaneously. It enables users to interact with virtual content through gestures, gaze, and voice commands, making it a powerful tool for industries like healthcare, engineering, education, and gaming.





# Dependence on Memory Devices in Microsoft HoloLens

## Real-Time Processing

HoloLens requires high-speed memory (like RAM) to handle real-time rendering of holograms and AR experiences.

Ensures smooth interaction with 3D models and virtual overlays.

## Environment Mapping

Stores and processes data from sensors like depth cameras, LiDAR, and IMUs to create accurate spatial maps.

High-performance memory helps process large datasets quickly for seamless AR integration.

## Storage of Holograms and Applications

Non-volatile memory (like SSDs) stores holographic content, applications, and system data.

Efficient storage allows for faster loading times and better multitasking.

In summary memory devices are vital for ensuring the speed, reliability, and efficiency of HoloLens in delivering immersive mixed-reality experiences.



# FUNCTIONALITY

- **Display Technology:**

The HoloLens uses transparent lenses to project digital images, known as holograms, into your field of view. These holograms are overlaid on the real world, creating a mixed reality experience.

  - **MicroLEDs:** Provide high brightness, contrast, and energy efficiency, essential for clear visuals in AR environments.
  - **LEDs and LCDs:** Earlier versions used these technologies for projection and display, but newer advancements favor MicroLEDs for better performance and reduced weight.
- **Sensors:**
  - **Cameras and Sensors:** The HoloLens has multiple cameras and sensors to map your surroundings. This allows it to understand the space around you, so holograms can be placed accurately on walls, tables, or in mid-air. **Eye Tracking:** It tracks where you're looking, so it knows which part of the hologram you're focusing on. **Movement Sensors:** Tracks your head and hand movements, enabling interaction with holograms.
- **Processing Unit:**

The HoloLens has a Holographic Processing Unit (HPU) and other processors to calculate:

  - Where to place holograms in the real world.
  - How to update holograms as you move around.
  - How to respond to your gestures or voice commands.



## ■ Interaction:

- Gestures: You can use hand gestures to grab, move, or resize holograms. Voice Commands: You can speak to the device to control holograms. Gaze and Click: You look at a hologram and use a "click" gesture or a connected device to interact with it.

## ■ Connectivity:

- The HoloLens connects to the internet and other devices, allowing you to collaborate with others in shared virtual spaces or access online data for your holograms.



Imagine you're an architect. With a HoloLens, you can walk around a room and see a 3D holographic model of a building sitting on a table. You can zoom in, rotate it, or even walk "inside" the hologram to explore it as if it were real.

"Microsoft HoloLens: The headset that lets you see holograms, work smarter, and still look like a sci-fi protagonist."