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

Name	Sr.No	Branch
Keerthana.D	01	CSE
Kiran.A	02	CSE
Kushi.M	03	CSE
Kushal Kumar	04	CSE
Lakkasani Venkata Rajasekhara Reddy	05	CSE

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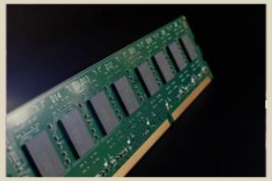
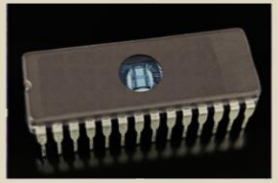
MEMORY DEVICES



Volatile Memory

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

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

A CAPACITY

B ACCESS TIME

C READ/WRITE OPERATIONS

CAPACITY	ACCESS TIME	READ/WRITE OPERATIONS
KILO BYTES MEGA BYTES GIGA BYTES TERA BYTES	Access time is the duration between the memory request and the completion of data transfer to or from memory.	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

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

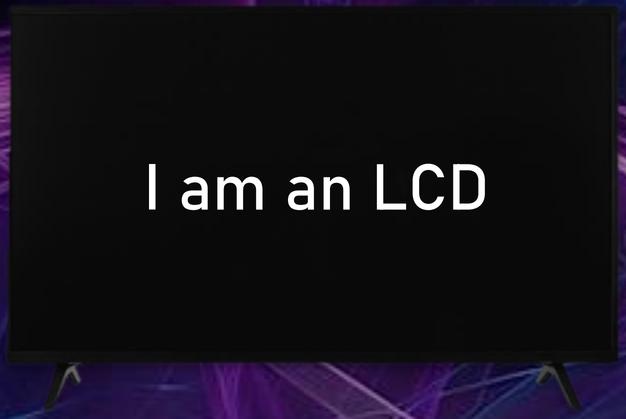
Photoactive Materials

- 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



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 mixed-reality smart glass headset that blends the physical and digital worlds by overlaying 3D holograms onto the real environment. 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 LED, LCD, and MicroLEDs

- **Display Technology:**
  - **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.
- **Optics:** LEDs and MicroLEDs enable the generation and projection of precise holograms, making them a backbone for realistic mixed-reality experiences.

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.