# List of Figures


| *Figures* | *Title* | *page* |
|---|---|---|
| 1.1 | Methods of deposition of organic molecules by solution processing: (a) Spin coating, (b) Dip coating, (c) Drop cast, (d) Blade coating, (e) Ink-jet printing, (f) Screen printing, and (g) Langmuir Blodgett deposition | 2 |
| 1.2 | Applications of organic molecular devices: (a) A flexible bio sensor (Image courtesy: www.osadirect.com), (b) Flexible solar cell (Image courtesy: ise.fraunhofer.de), (c) A flexible memory chip (Image courtesy: Dickey M., phys.org), (d) A 65 inch flexible OLED display (image courtesy: lg.com) | 4 |
| 1.3 | Illustration of organic molecules: (a) An organic molecule with double bonds at alternate positions, (b) Electronic cloud in conjugated organic molecule, (c) Electronic cloud in simplest conjugated structure – Ethylene, (d) Formation of bonding and antibonding orbitals' energy levels in ethylene | 5 |
| 1.4 | Hierarchy of memories in a computer system. Auxiliary memories are at the far end of the system storing large files or backup data for a long time whereas main memories interact with the CPU directly. Cache memory is an ultra-high-speed memory which provides the frequently used data to the CPU | 6 |
| 1.5 | Current voltage characteristics of a conductance switching memory. $V_r$, $V_w$ and $V_e$ respectively are the read, write and erase voltage levels. Observe that at a same voltage $V_r$, there are two values of current namely $I_{ON}$ and $I_{OFF}$. Arrows show the direction in which voltage is increased/decreased | 8 |
| 2.1 | The DSA100-$SK_2$-4.0L Ultrasonic cleaner from Phoenix instrument used in the current study | 11 |
| 2.2 | Spin coating: (a) Schematic diagram depicting spin coating process, (b) The spin coating system used in the current study - spinNXG-P1 from Apex Equipments | 12 |
| 2.3 | (a) Schematic diagram of a thermal evaporation system, (b) SC-Triaxis thermal evaporation system from Semicore used in experiments | 13 |
| 2.4 | (a) A schematic diagram of a basic surface profiling scheme, (b) DektakXT surface profilometer system from Bruker used in measurements | 14 |
| 2.5 | (a) Schematic representation of working of AFM (b) SPM XE-70 by Park Systems used in the characterizations in the current study | 15 |
| 2.6 | (a) Schematic and basic working principle of scanning electron microscope (b) EVO-18 special edition scanning electron microscope from Carl Zeiss used in characterization | 16 |
| 2.7 | (a) Schematic diagram of basic principle of a spectroscopy system, (b) UV1800 spectrophotometer from Shimadzu, used in the characterization | 17 |
| 2.8 | (a) Subfemtoampere 6430 source meter by Keithley-Tektronix used for electrical characterization, and the vacuum chamber in the background, (b) Top view of the vacuum chamber in which IV characterization is carried out | 18 |
| 2.9 | Front panel of Voltage Sweep VI with batch processing and Logarithmic output display | 19 |
| 2.10 | Block diagram of the Voltage sweep VI (a) Initialization of parameters, (b) Voltage sweep calculation, measurement and manipulation part, (c) saving the result and alarm notification upon completion. | 20 |
| 2.11 | Front panel of Long-Run VI with Current v/s time display | 21 |
| 2.12 | Block diagram of the Long-run VI (a) Initialization of parameters, (b) real time measurement, graph plotting and accumulation of the data. | 22 |
| 2.13 | Front panel of the periodic read-write-erase VI | 22 |
| 2.14 | Block diagram of the periodic Read-Write-Erase VI (a) Initialization of parameters, (b) real time measurement and graph plotting, and the accumulation of the data. | 23 |
| 3.1 | (a) Molecular structure of DDQ and PVP. (b) Schematic design of the metal insulator metal (MIM) memory devices based on DDQ-PVP blend | 26 |
| 3.2 | Absorption spectra of pristine DDQ and PVP and mixtures of both at various concentrations (5% - 30% with a 5% increase of DDQ in PVP and 50% of DDQ in PVP) in IPA | 27 |
| 3.3 | AFM images of DDQ and PVP having (a) - (g) 5%, 10%. 15%, 20%, 25%, 30%, and 50% of DDQ (w/w) with respect to PVP. The scale bars show a distance of 1 $\mu$m. | 28 |

| | | |
|---|---|---|
| 3.4 | (a) IV characteristic curve of device A. The numbered (1 to 4) arrows (red, orange, yellow, and green) represent the sequence of scanning. (b) and (c) IV characteristic curves for devices B and C, scanned from 3 to -3V. The inset of (b) shows the ON/OFF ratio for the device within the spectrum of the above voltage scan and the inset of (c) shows the polarity of the I-V characterization scheme. (d)–(g) The IV characteristic curves of devices D, E, F, and G. | 29 |
| 3.5 | (a) Schematic of conduction mechanism in the devices showing formation of the aluminum filament at lower DDQ concentration and conformational change of DDQ at the higher concentration. The yellow region represents parts of DDQ, the light blue region is PVP matrix, and the orange color balls represent Al ions. (b)-(d) IR images of top Al electrode while a bias voltage of -3V, +3V and -3V is applied respectively. | 30 |
| 3.6 | (a) The endurance test: write-read-erase-read sequence to test the consistency of reading the written and erased states which are written at -3 V, and erased at 3 V. (c) Retention study of device: After writing and erasing by -3 V (ON state) and 3 V (OFF state) respectively, the states are read for 1000 s | 31 |
| 4.1 | (a) Molecular structures of DDQ and PVP (b) schematic of the ITO/PVP:DDQ/Al device structure; the crossbar architecture makes sure that the probes don't short circuit the device while IV characterization. | 34 |
| 4.2 | The absorbance spectra of individual components along with the mixture of PVP and DDQ | 35 |
| 4.3 | (a) – (e) AFM images of the active layers of DDQ and PVP deposited by spin coating at rpms 1000, 2000, 3000, 4000, and 5000. The white bar in each image indicates a distance of 400 nm. The green circle and red rectangle show the small and big structures respectively. | 36 |
| 4.4 | (a) – (b) Cross sectional scanning electron microscope (SEM) images of devices deposited at 1000 to 5000 rpm, respectively, with an increment of 1000 rpm. The orange color stripe represents Al, yellow color stripe represents active layer and green color stripe represents ITO in all images. The rectangle represents the spot where the EDX was observed. The horizontal black bar represents distances of 200, 300, 200, 200 nm, and 1$\mu$m respectively | 37 |
| 4.5 | (a) – (e) I-V characteristics for the devices fabricated at 1000 – 5000 rpm with an increase of 1000 rpm. The arrows in (a) and (e) show the direction of voltage scan. (f) Variation of ON-OFF ratio with RPM of rotational speeds at which the devices were spin coated. | 38 |
| 4.6 | (a)-(e) Schematic of proposed model for the switching mechanism of the devices prepared with the spin coating method at the speeds ranging from 1000-5000 rpm with an increase of 1000 rpm. | 39 |
| 4.7 | The write–read–erase–read voltage pulse cycle with $V_{write}$ = −4 V, $V_{erase}$ = 4 V and $V_{read}$ = − 1.5 V are applied for 5, 5, and 10 s, respectively. (b) Retention time study with $V_{read}$ = − 1.5 V, and $V_{write}$ and $V_{erase}$ being − 4 and 4 V applied for 5 s, respectively. The train of current at − 1.5 V followed by write and erase voltage pulses are called as on and off state current and are measured for more than 2000 s | 40 |