

Supplementary Material

X-ray Photoelectron Spectroscopy (XPS):

The X-ray photoelectron spectra was recorded using Al K_{α} radiation (1486 eV). Fig. 1(a) gives the survey scan of the AD- x AZO (where, $x = 0.5, 1.0, 2.0$ and 3.0 at.wt.%) thin films. In these scans the Al $2p$, Zn $2p_{3/2}$, Zn $2p_{1/2}$ O $1s$, C $1s$ peaks along with the Zn LMM Auger transition are clearly observed. Detailed scan of Al $2p$ in AD- x AZO thin films with $x = 0.5, 1.0, 2.0$ and 3.0 at.wt.% is as shown in the Fig. 1(b).

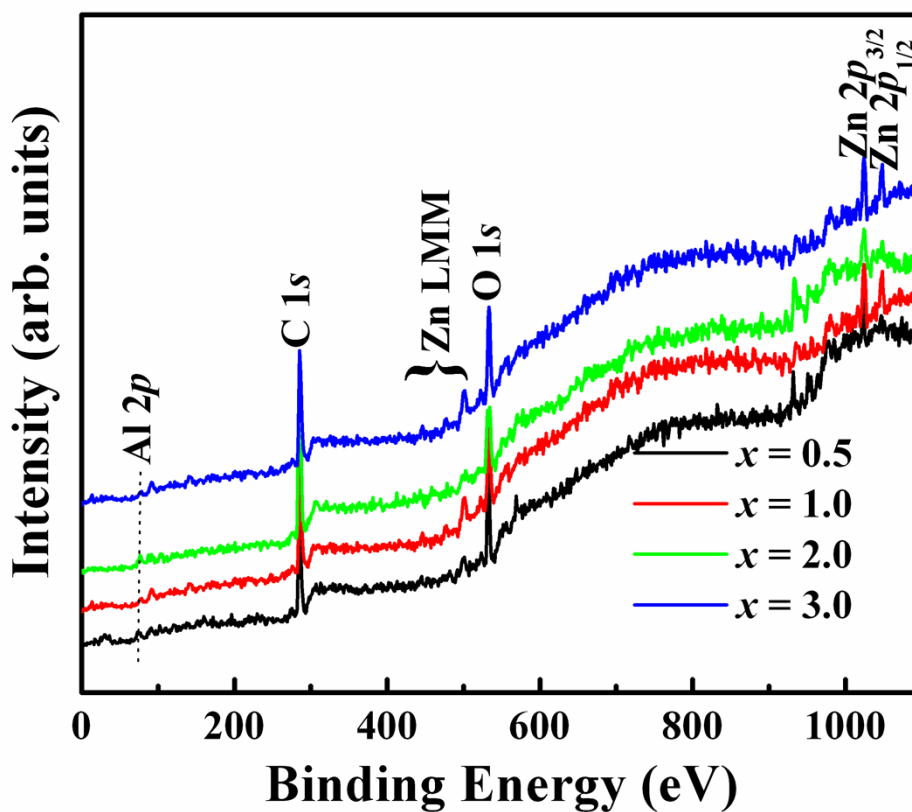


Fig. 2(a) XPS survey scan of AD- x AZO thin films, where $x = 0.5, 1.0, 2.0$ and 3.0 at.wt.%.

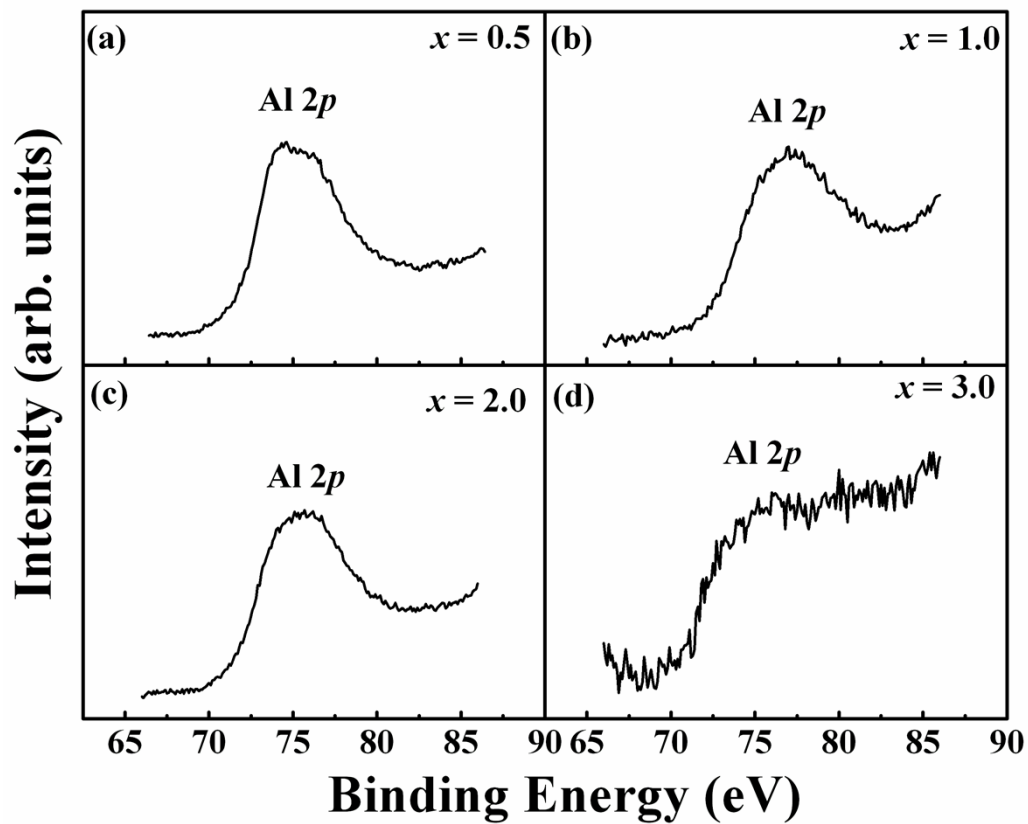
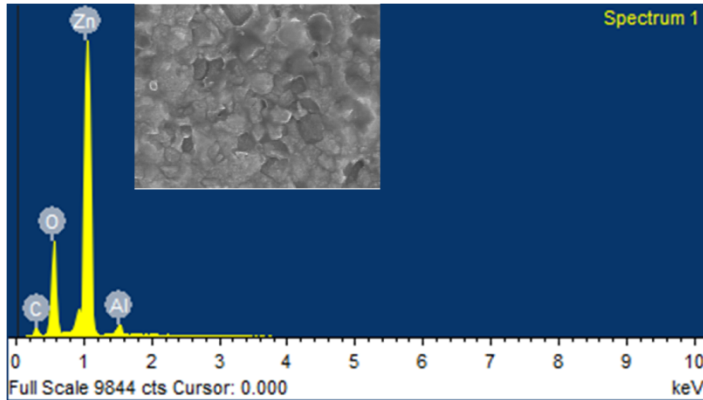


Fig. 2(b) Detail scans of Al 2p peak AD-xAZO thin films, where $x =$ a) 0.5, b) 1.0, c) 2.0 and d) 3.0 at.wt.%.

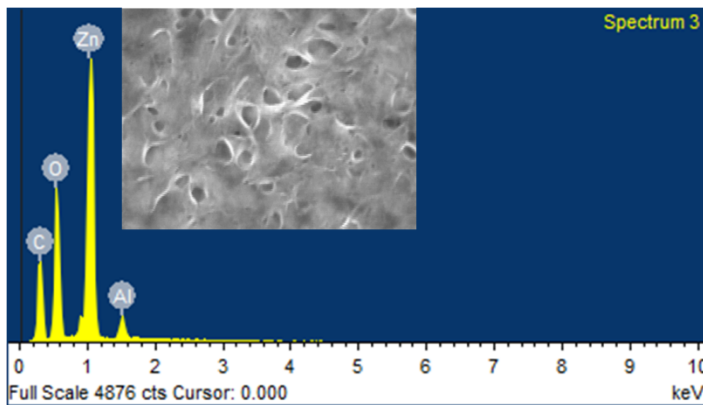
Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS):

We have attempted to record the Energy Dispersive Spectroscopy for carrying out the compositional analysis of our samples. The concentration of Al appears to be high indicating that the Al from the substrate ($c\text{-Al}_2\text{O}_3$) is also contributing to the spectra. Figure 2 presents the recorded data viz. a) EDS spectra, b) table indicating the concentrations and c) the FE-SEM image as an inset.



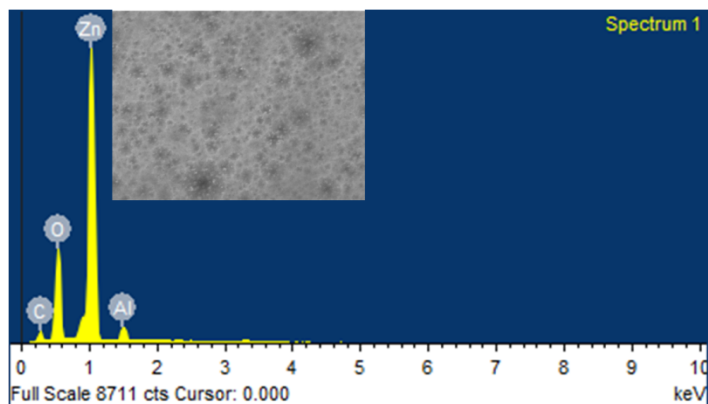
(a)

| Element | Weight% | Atomic% |
|---------|---------|---------|
| C K | 5.29 | 14.60 |
| O K | 23.16 | 47.97 |
| Al K | 1.61 | 1.98 |
| Zn K | 69.94 | 35.46 |
| Total | 100 | |



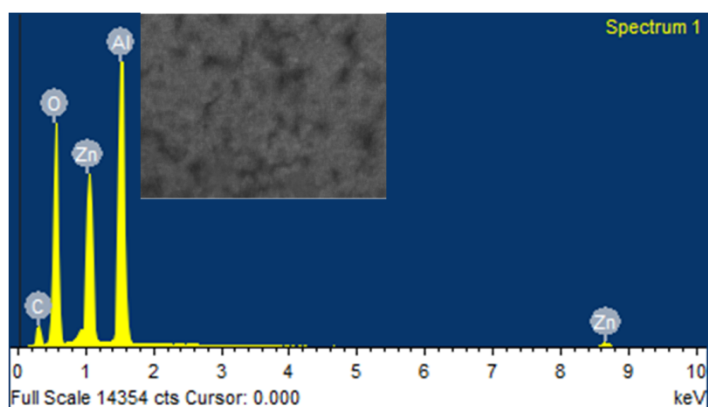
(b)

| Element | Weight% | Atomic% |
|---------|---------|---------|
| C K | 15.47 | 36.29 |
| O K | 20.16 | 35.51 |
| Al K | 0.75 | 0.78 |
| Zn K | 63.62 | 27.42 |
| Total | 100 | |



| Element | Weight% | Atomic% |
|---------|---------|---------|
| C K | 24.97 | 49.02 |
| O K | 20.69 | 30.49 |
| Al K | 1.74 | 1.52 |
| Zn K | 52.61 | 18.98 |
| Total | 100 | |

(c)



| Element | Weight% | Atomic% |
|---------|---------|---------|
| C K | 11.50 | 20.24 |
| O K | 40.59 | 53.64 |
| Al K | 23.09 | 18.09 |
| Zn K | 24.81 | 8.02 |
| Total | 100 | |

(d)

Fig. 1 EDS recorded spectra of AD-xAZO thin films where, $x =$ a) 0.5, b) 1.0, c) 2.0 and d) 3.0 at.wt.%. The inset shows the FE-SEM images of respective thin films.

Films with 1.0 and 2.0 at.wt.% show relatively closer values of Al content. In case of 0.5 and 3.0 at.wt.% the results indicate higher values.