

# High-Throughput Fabrication of Functionalized Carbon Nanostructures for DNA Detection



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## OBJECTIVE

- To fabricate and characterization of controllable carbon nanostructures at desired positions
- Surface functionalization of carbon nanostructures for biomolecular detection

## INTRODUCTION

The current trend of biosensing is moving towards the realization of point-of-care diagnostic systems which involve the integration of all the analytical stages on a single chip. Carbon nanostructures such as carbon nanotubes (CNTs) are best suited as the active elements for such devices due to their unique properties. However, controlling the carbon nanotube growth at pre-defined locations with desired properties is still a big challenge. In this regard we believe that other one-dimensional nanostructures could also be favorable as biosensing electrodes to achieve higher sensitivity and shorter response times.

## EXPERIMENTAL PROCEDURE

### PHOTO-NANOIMPRINT LITHOGRAPHY PROCESS

The polymer nanostructures were fabricated using the Photo-Nanoimprint Lithography process

The as fabricated polymer nanostructures were carbonized at 1000°C in forming gas (95% N<sub>2</sub>+5% H<sub>2</sub>)

The fabrication methodology is shown in Figure 1

The shape, position and distance between carbon nanostructures can be varied by changing the processing conditions

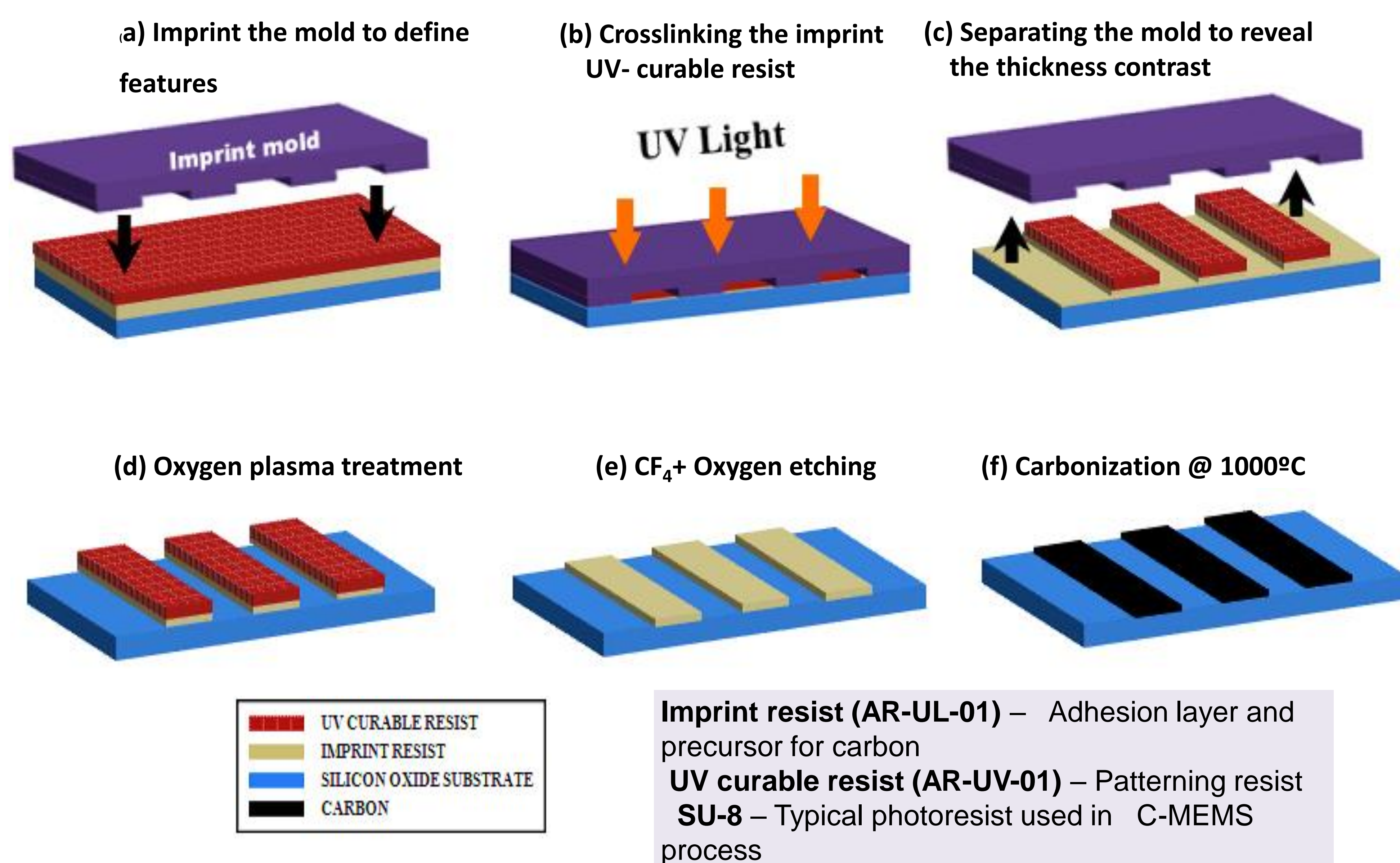


Fig 1. Schematic showing the fabrication methodology

## RESULTS

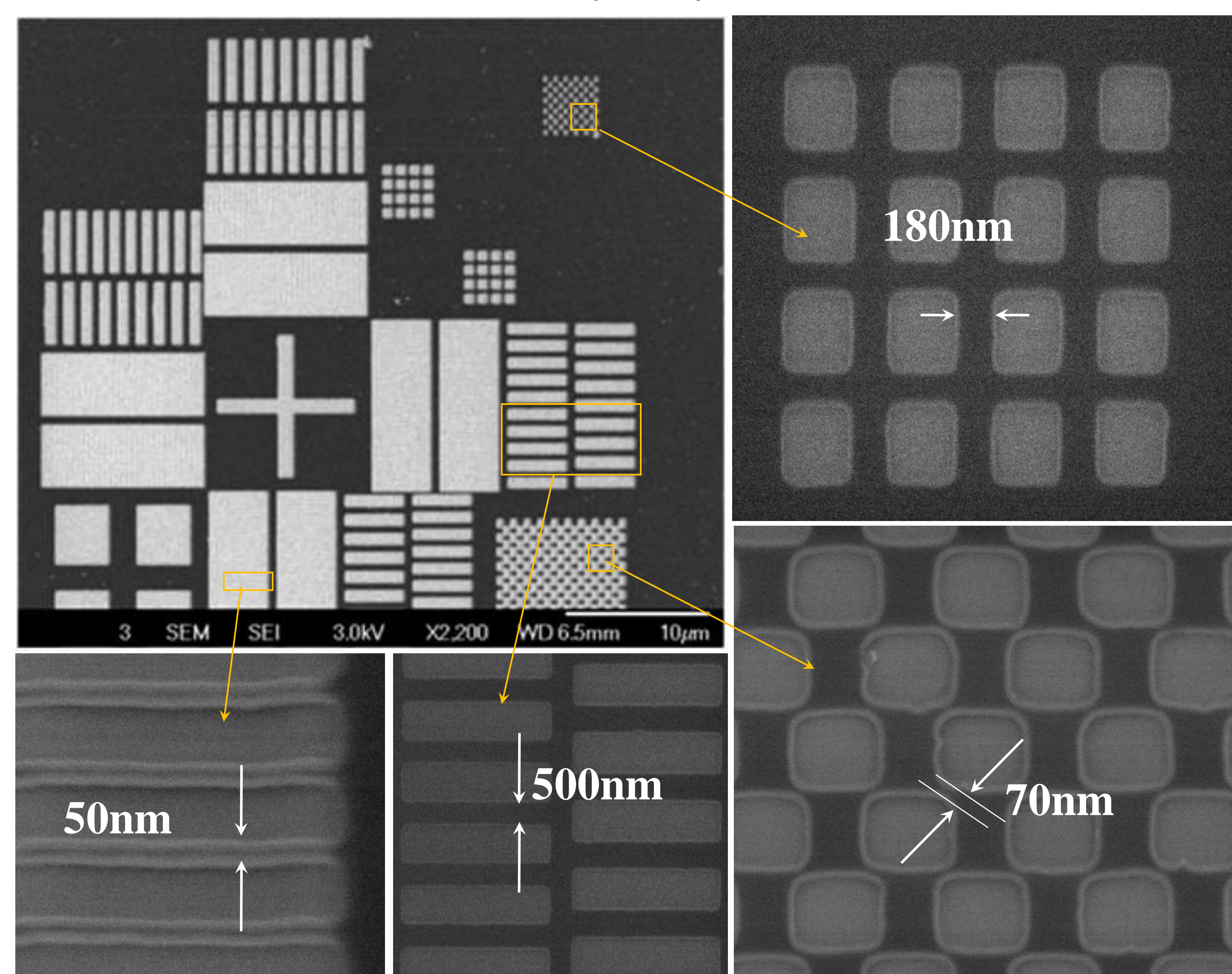


Fig 2. SEM images showing carbon nanostructures with different dimensions

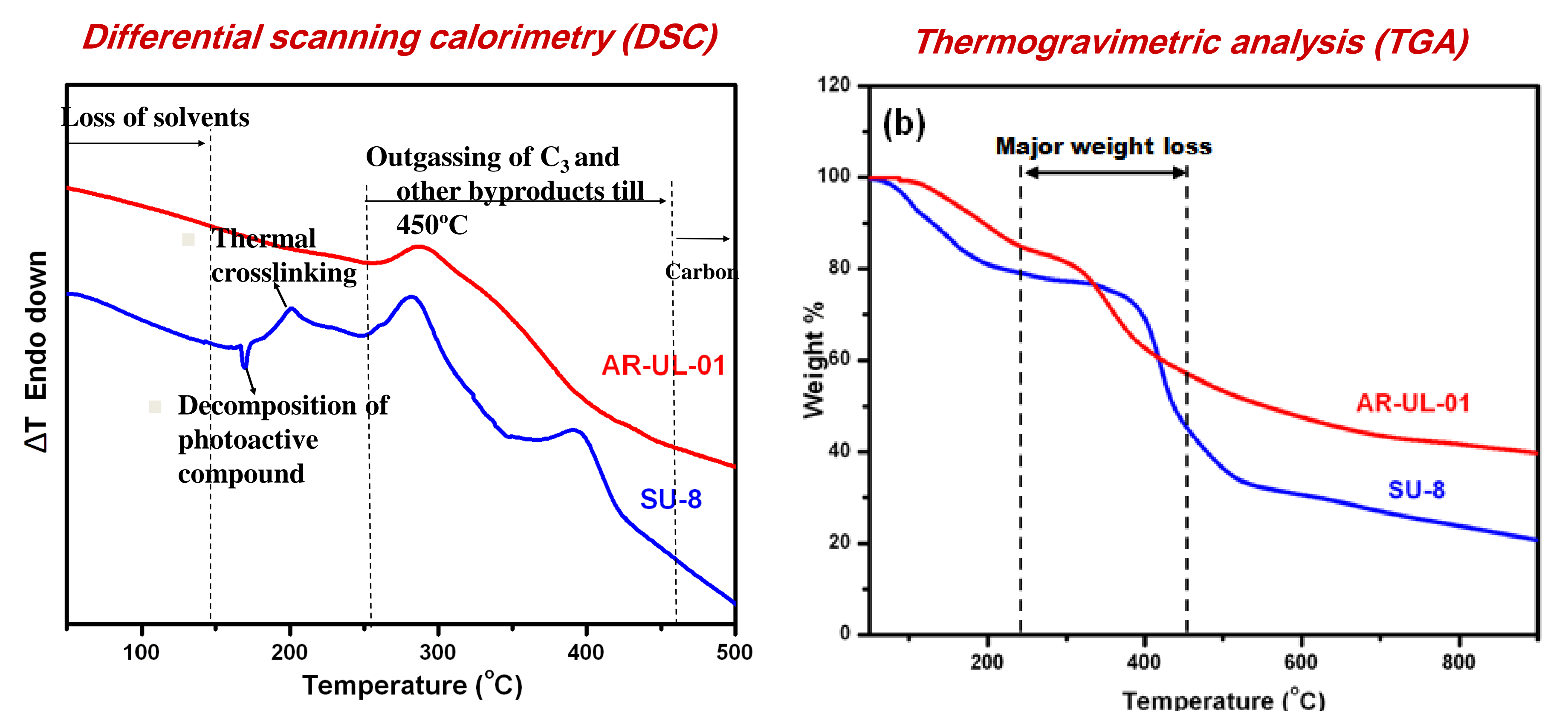


Fig 3. Thermal characterization of AR-UL-01 polymer using DSC and TGA spectra

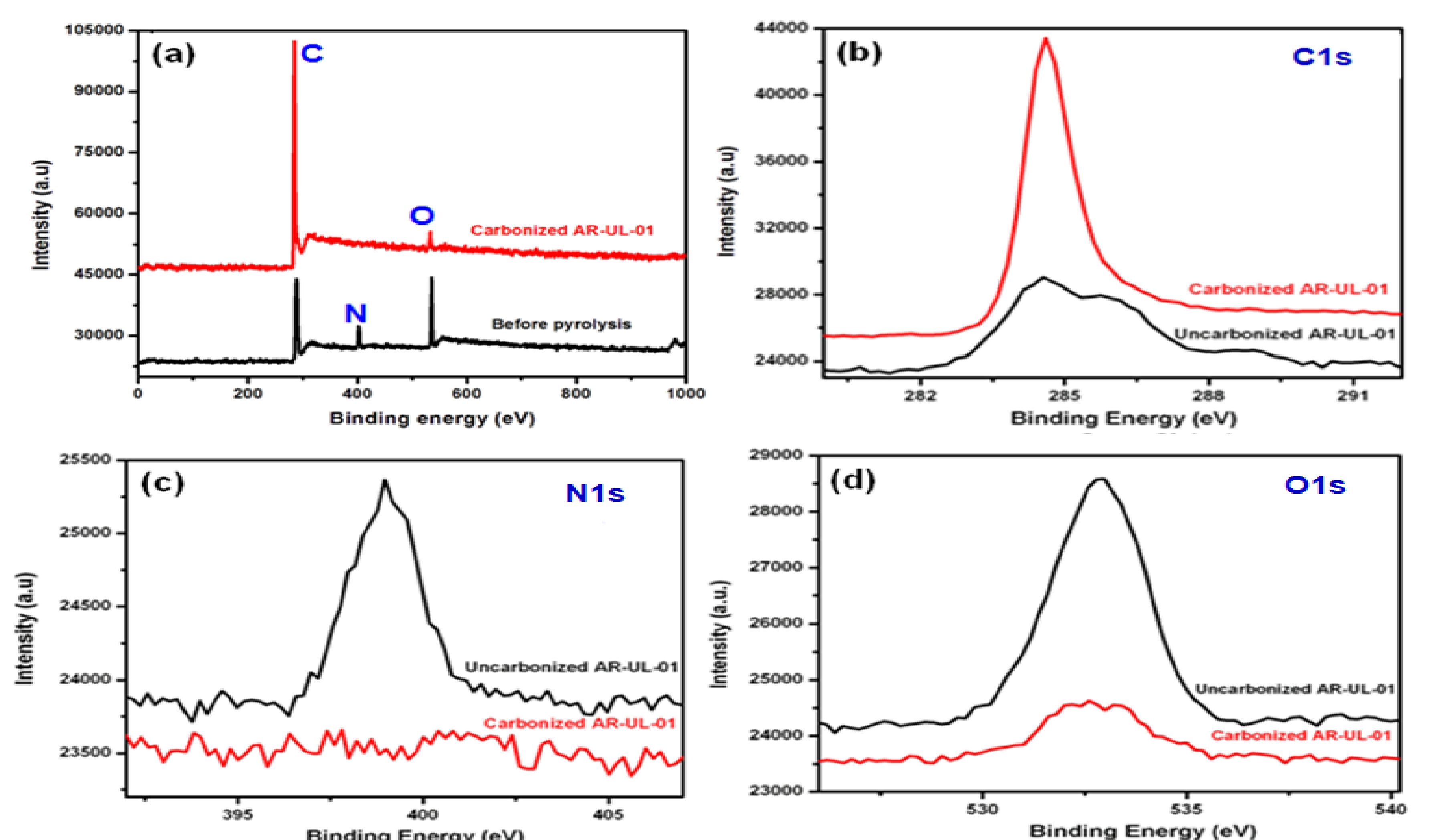
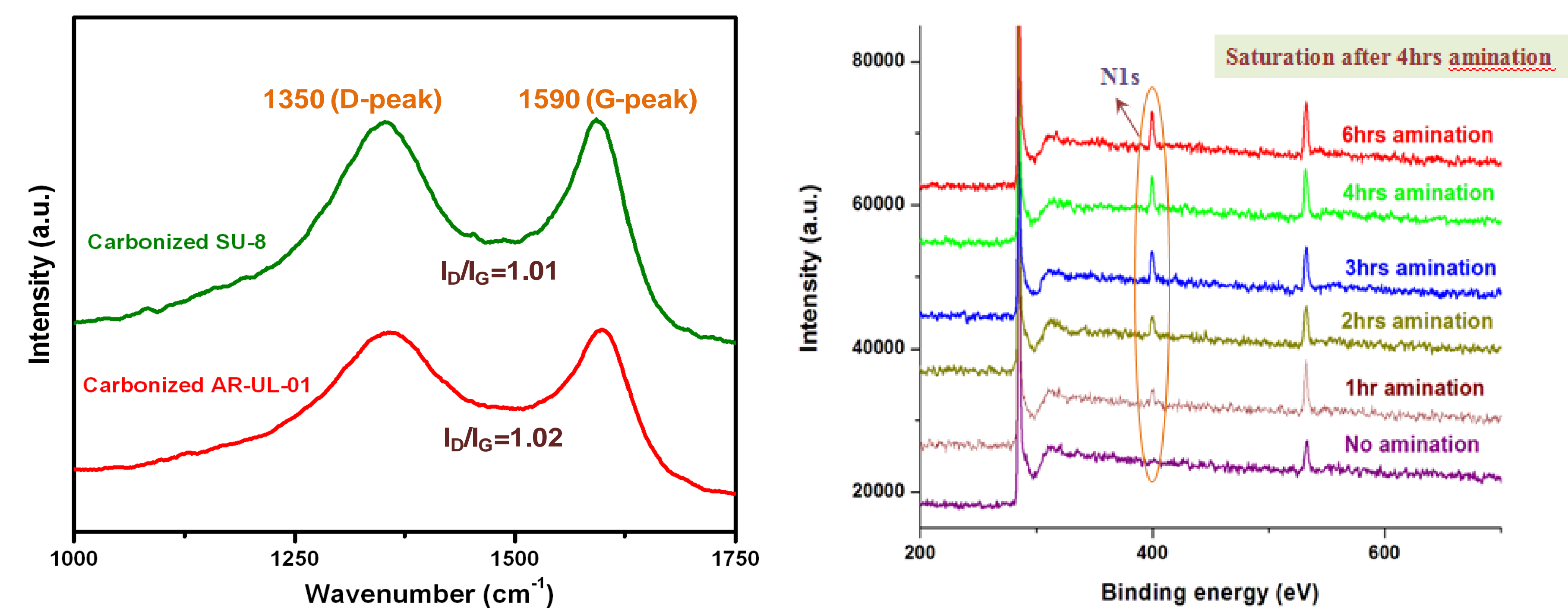


Fig 4. XPS spectra of AR-UL-01 before and after pyrolysis



## DISCUSSION

- SEM images shows smallest feature was 50nm gratings and the lateral fidelity was maintained through pyrolysis cycle
- XPS spectra shows that carbon, nitrogen and oxygen peaks visible before pyrolysis but nitrogen peak not visible after pyrolysis due to outgassing
- Decrease in the O/C ratio from  $22.8 \pm 0.4$  to  $0.52 \pm 0.5$  was observed after pyrolysis. Raman spectra show a similar  $I_D/I_G$  compared to PPF
- XPS results confirm the successful surface functionalization of the surface by direct amination technique. The amount of surface functionalization changed with amination time

## CONCLUSIONS

Fabricated controllable carbon nanostructures at pre-defined positions and this technique is capable to fabricate both micro and nanofeatures simultaneously at the wafer level. Volume shrinkage, microstructure and chemical composition were identical to typical pyrolyzed photoresist films. Surface functionalization was successful by direct amination for subsequent immobilization of biomolecules

## ACKNOWLEDGEMENTS

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