

Depth profiling of thin plasma-polymerized polyamine films using GDOES, ToF-SIMS and XPS techniques

Janez Kovač¹, Jernej Ekar^{1,2}, Miha Čekada¹, Lenka Zajíčková^{3,4}, David Nečas³, Lucie Blahová³, Jiang Yong Wang⁵, Miran Mozetič¹

¹ Jozef Stefan Institute, Ljubljana, Slovenia

² Jozef Stefan International Postgraduate School, Ljubljana, Slovenia

³ Central European Institute of Technology – CEITEC, Brno University of Technology, Czech Republic

⁴ Department of Condensed Matter Physics, Faculty of Science, Masaryk University, Brno, Czech Republic

⁵ Department of Physics, Shantou University, Shantou, Guangdong, China

Keywords: GDOES, XPS, ToF-SIMS, depth profile, polyamine

Abstract

Depth profiling using GDOES, XPS and ToF-SIMS methods was compared on the thin polymer films of thickness of 70 nm and 500 nm and deposited by PECVD from a cyclopropylamine precursor [1]. These depth profiles were evaluated in terms of sputtering rate, depth resolution, sensitivity and artefacts. The GDOES depth profiling was considered in more details involving the erosion of the polymer films in an asymmetric RF capacitively coupled discharge using both Ar and Ar-O₂ gases. The application of pure Ar caused unwanted effects, such as the broadening of the polymer-film/substrate interface, which were suppressed when using the mixture with oxygen. Another benefit of oxygen for GDOES was a significant increase in the etching rate by a factor of about 15 as compared to pure argon. The mechanisms involved in the depth profiling using the mixture of gases were elaborated in some detail, taking into account plasma parameters typical for an asymmetric, capacitively coupled RF discharge in a small volume. The main benefit of using the Ar/O₂ GDOES profiling with respect to XPS and SIMS depth profiling is the increased sputtering rate for polymer films. Comparing the GDOES depth profiling with the Ar/O₂ mixture with profiling in pure Ar, the benefits are a higher sputtering rate and better depth resolution at the polymer/substrate interface.

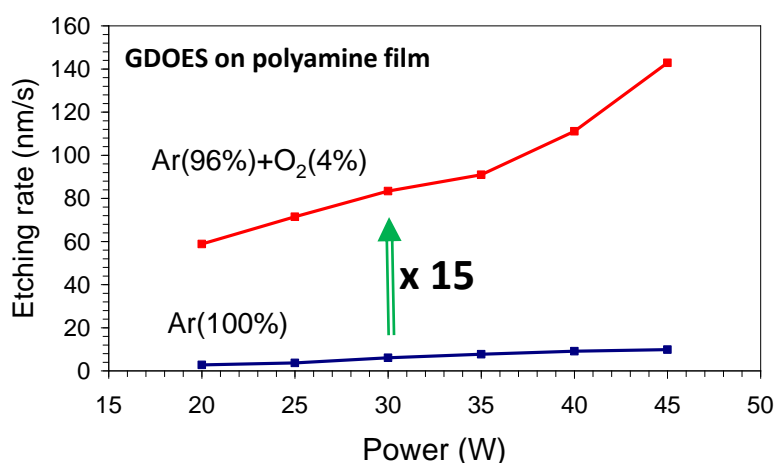


Figure 1: GDOES depth profiling in Ar/O₂ mixture increases etching rate by a factor of about 15 for polyamine polymer film compared to pure Ar gas

References

[1] J. Kovač, J. Ekar, M. Čekada, L. Zajíčková, D. Nečas, L. Blahová, J. Yong Wang, M. Mozetič, Depth profiling of thin plasma-polymerized amine films using GDOES in an Ar-O₂ plasma, *Applied Surface Science*, 581 (2022) 152292.

Acknowledgements

The authors acknowledge the financial support from the Slovenian Research Agency (research core funding No. P2-0082 and project L2-1728), the CzechNanoLab Research Infrastructure supported by MEYS CR (LM2018110) and the project 21-12132J supported by the Czech Science Foundation.