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# Single cathode combinatorial deposition using powder target by sputtering process

T. Ohshima[1], G. Yazaki[1], S. Takeichi[2], Y. Hibino[2], T. Ihara[2], and H. Kawasaki[2]
[1] Graduate school of Integrated Science and Technology, Nagasaki University,
[2] Department of Electrical and Electronic Engineering, National Institute of Technology, Sasebo College
e-mail (speaker): ohshima@nagasaki-u.ac.jp

The development of high-performance and novel functional materials is essential for addressing societal challenges and achieving the Sustainable Development Goals (SDGs). However, conventional methods for material discovery in specific application fields have reached their limitations and must be extended to explore previously unknown multi-element material systems. One major challenge in discovering such materials is the increased development time due to the larger number of elements involved. As a result, the combinatorial deposition method is gaining attention as a high-throughput technology. This technique involves forming compositional gradient films by simultaneously sputtering multiple targets within a sputtering chamber. However, it is costly, as it requires multiple cathodes or specialized masks.

An alternative and promising approach for the rapid discovery of multi-element thin films is powder sputtering—a deposition method that uses powder as the target material. Powder targets offer extensive flexibility in the combination of elements and their compositional ratios. Additionally, the method of filling the target holder with powder can be varied. Multiple powders can be placed within a single target holder, enabling the fabrication of compositional gradient films even in a single-cathode sputtering system.

In this study, we fabricated transparent conductive thin films of gallium-doped zinc oxide (GZO). As illustrated in Figure 1, equal amounts of ZnO and $Ga_2O_3$ powders were loaded into a 100 mm diameter target holder, and GZO thin films were deposited onto 4-inch Si wafers using RF magnetron sputtering with a single cathode. Figure 1 shows the deposition process and the spatial distribution characteristics of the GZO thin films produced using powder targets. As depicted, we successfully obtained GZO thin films with low electrical resistance, with a Ga content about of 3 at% in the film.

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References

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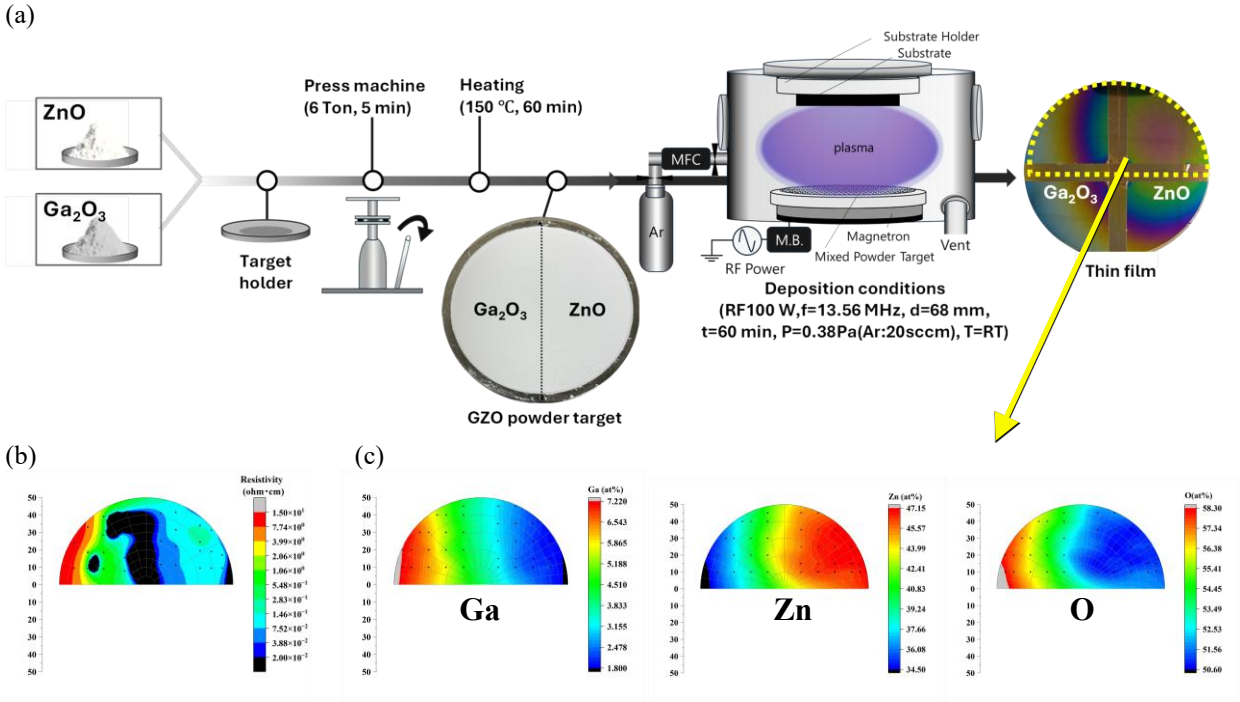


Figure 1. (a) GZO thin film fabrication process using powder target, (b) Mapping the spatial variation of resistivity, and (c) Mapping the spatial variation of atomic concentration (Ga, Zn, O).