Preface

The most straightforward method to change the surface properties of a material is to deposit a thin film or coating on it. Hence, it is not surprising that an overwhelming amount of scientific and technical papers is published each year on this topic. Sputter deposition is one of the many so-called physical vapour deposition (PVD) techniques. In most cases, sputter deposition uses a magnetically enhanced glow discharge or magnetron discharge to produce the ions which bombard and sputter the cathode material. In the first chapter of this book (Chap. 1), the details of the sputter process are discussed. Essential to sustain the discharge is the electron emission during ion bombardment. Indeed, the emitted electrons are accelerated from the target and can ionize gas atoms. The formed ions bombard again the target completing the sustaining process. A complete chapter is assigned to this process to highlight its importance (Chap. 2). Although the sustaining process can be described quite straightforward, a complete understanding of the magnetron discharge and the influence of different parameters on the discharge characteristics is only possible by modelling (see Chap. 3). With these three chapters, the reader should be able to form an idea of the target and plasma processes occurring during a DC magnetron discharge.

When a reactive gas is added to the discharge, it becomes possible to deposit compound materials. This process is called *reactive sputter deposition*. The changes of the deposition process as a function of the reactive gas addition are discussed in Chaps. 4 and 5. The former (Chap. 4) describes the well-known "Berg" model, which enables a better understanding of the general aspects of reactive magnetron sputtering. The next chapter (Chap. 5) summarizes several experimental results and shows the need to more detailed models to describe the reactive sputtering process.

One of the major problems of the reactive sputter process is its complexity and several fundamental aspects of the process have not been elucidated yet. Only by understanding all its details, it is possible to understand the properties of the obtained thin film as a function of the deposition conditions. In this respect, it is necessary to describe the deposition flux towards

the substrate. This can be achieved by modelling the transport of sputtered particles towards the substrate (Chap. 6). However, not only the metallic flux but also the energy flux towards the substrate is important. This latter forms the subject of the following chapter (Chap. 7). More details of the reactive magnetron sputter process can be achieved by a good knowledge of the available plasma diagnostic tools. Hence, they form the content of the next two chapters (Chaps. 8 and Chap. 9). A nice illustration of the implementation of these tools is shown in the Chap. 10 which demonstrates their use in the study of the cross-corner and cross-magnetron effect (Chap. 10).

Finally, the book ends with some interesting examples of materials deposited with reactive sputter deposition. Indeed, complex materials such as solid electrolytes (Chap. 11), complex oxides (Chap. 12) and electrochromic thin films (Chap. 13). In the last chapter, the reader can learn more about the simulation of the growth of thin film deposited by magnetron sputtering (Chap. 14).

Although the technique is easy to use, it conceals enough challenges to remain scientific interesting. This explains its popularity in the academic world. Also in the industrial world, reactive magnetron sputtering remains an interesting and often used technique, due to its flexibility and scalability and has gained in this way a strong position for large-area deposition of thin films. As for most thin film deposition techniques, sputter deposition was once considered a black art and only in the last two decades, there has been a vast increase in the range of material types which can be deposited, the complexity of thin films which are possible, the ability to deposit precisely controlled heterostructures and the reproducibility of film deposition. The origin of this change is the trend to analyse in more detail all relevant processes during the thin film deposition to maximize the level of control. This forms exactly the goal of this book, i.e. to give the reader on overview of the important processes during sputter deposition and of the aim to describe them by modelling and to use them to deposit complex materials such as perovskite, solid electrolytes and electrochromic thin films. A good understanding of the reactive sputtering process is essential when tailoring the thin film properties. This reasoning formed also the guideline for the table of content which mimics a virtual journey from target towards substrate.

Together with the authors, we hope that the different topics discussed in the book will help the novice and experienced scientist to solve some of the problems encountered during the use of this interesting deposition technique.

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Diederik Depla
Stijn Mahieu
www.draft.ugent.be

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