Memristive devices based on NbO_x

Abstract and summary

With the Moore's Law coming to an end, the continuous growth of data in the era of Internet of Things requires the development of new technologies to overcome Von Neumann bottleneck that limits current computing technologies. In this framework, memristive devices in form of Redox Random Access Memories (ReRAMs) have recently attracted great attention for the development of next-generation memory storage and for the in-memory computing (CIM). The working principle of these devices relies on the so-called resistive switching mechanism, e.g. the passage between two resistance states, the High resistance state (HRS) and the Low resistance state (LRS) through the application of an external voltage stimulus. These two resistance states can be ascribed to the "0" and "1" outputs of the conventional CMOS transistor-based memories. Despite demonstration of efficient processing of information and computational capabilities, details underlying physicochemical mechanisms in memristive devices still needs to be explored.

In the present work, Metal-Insulator-Metal (MIM) devices based on anodic NbO_x are proposed to study how the different materials involved in the fabrication affect the RS properties of the aforementioned devices. After a first general introduction on the memristive devices, in the second chapter the attention will be focused on the characterisation of the oxide layer properties, from the study of the structural to the chemical analysis, then, through suitable electrical measurements, connection between the material properties and the switching capabilities will be discussed. In the third chapter, the attention will be devoted on the study of different metal electrode materials and correlations between the choice of the Top Electrode (TE) metal and the switching capabilities of the realised devices will be described. The choice of the TE metal in the VCM devices plays an important role in the switching capability of the NbO_x. In particular, these results will be used as guide line to delineate a possible selection rule for the realisation of NbO_x-based memristive devices. Alongside to the switching properties, even the possibility to observe quantum conductance capabilities will be shown. Finally, conclusions and perspectives of the NbO_x devices will be discussed.