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# Characterisation of GeTe phase change material deposited by plasma assisted MOCVD

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Phase-Change Random Access Memories (PCRAM) are very promising candidates for next generation of non-volatile memories. Those devices store information using the high electrical contrast between the amorphous and crystalline phases of chalcogenide alloys such as $Ge_2Sb_2Te_5$ (also called GST) which are mainly deposited by physical vapour deposition (PVD)[1]. However, two important drawbacks have to be overcome: a too short archival life for GST at high operating temperatures and a too high power consumption. The binary compound GeTe seems to be a promising candidate for high temperature applications since it has an estimated archival life up to ten years at 110°C. A pronounced increase in thermal stability of N- and C-doped GeTe was also demonstrated [2].

For the problem of power consumption, it was shown that a way to reduce the high operating currents is to confine the material. In this way, several groups try to develop a new deposition process to achieve the gap filling of the confined structure. Atomic Layer Deposition (ALD) of GST has shown very good step coverage but the deposition rate remains very low. Therefore we proposed to study the deposition of GeTe in a shower-head type 200mm plasma-enhanced pulsed liquid injection CVD reactor (AltaCVD200). Ge and Te liquid precursors are introduced into the deposition chamber as vapours through a pulsed injection system and an evaporating furnace. A capacitively-coupled RF plasma is applied between the shower head and the substrate heater to decompose the precursors. The role of the plasma in the process is multiple: optimisation of the substrate before deposition, participation to the precursor decomposition thanks to electron or hydrogen atoms impact; enhanced diffusivity of adspecies[3], etching the CH groups at the surface of the growing films. Moreover, thanks to the plasma assistance, the temperature of the substrate during the deposition can be as low as 150°C so that amorphous as well as crystalline films can be deposited. The deposition chamber is mounted on a cluster tool which allows quasi *in situ* analysis of the deposited films by angle-resolved XPS while the plasma is analyzed by optical emission spectroscopy (OES).

In this work, we investigate the influence of many process parameters such as gas flow rate, pressure in the reactor or plasma power on the chemical, physical and electrical properties of the deposited GeTe material. Role of C contamination in the phase change properties is also discussed and phase transitions of plasma deposited GeTe-C materials are compared with sputtered GeTe-C. Thanks to correlation between in situ analysis of the deposited material by XPS and OES analysis of the plasma, mechanisms of the deposition process are discussed. These results also provide information and first general insight onto the deposition process mechanisms that are ruling the conformity of the GeTe films. Conformity is analysed thanks to deposition in patterning substrates. Moreover, process uniformity and reproducibility is also monitored and optimized thanks to the development of a specific clean chamber process. It is therefore demonstrated a very good reproducibility of the process as evidenced in figure 1.

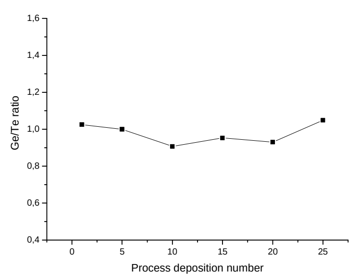


Fig 1 : Ge/Te ratio evolution as a function of deposited process number

To conclude, with this work we will demonstrate that, using PE-MOCVD deposition, we are able to obtain a perfect control of the stoichiometry, to control the carbon level and consequently the crystallisation temperature and to have a speed deposition close to 10 nm by minute which lead to a good uniformity of the deposition.

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