Excimer Laser Assisted Processing of Silicon-Germanium-Carbon Films

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The aim at enhancing the performance of solar cells and microelectronic devices through band gap engineering caused an increasing attention in processes for growing thin silicon-germanium-carbon (SiGeC) films in a wide range of composition and crystalline structure. Moreover, the demand for using cheap organic substrates and the development of new devices with advanced materials and sophisticated structures for nano-electronic based technologies, implies the need of "soft" alternative processing techniques that can avoid high substrate temperatures and allow processing on large, as well as on nano-scale areas .

ArF-Excimer **L**aser induced **C**hemical **V**apour **D**eposition (ArF-LCVD) (Fig.1a), **E**xcimer **L**aser assisted **C**rystallisation (ELC) (Fig.2a) and **P**ulsed **L**aser **I**nduced **E**pitaxy (PLIE) (Fig.3a) are such alternative "low thermal budget" techniques that are relatively cheap and compatible with conventional IC silicon technology, properties that are indispensable for being considered as an option in the development and the production of new devices.

This contribution briefly remembers the very basic principles of these laser assisted techniques and shows some typical results that we have achieved combining them, thus demonstrating the great potential of integrated laser assisted single chamber processes [1-3]. The growth of thin amorphous hydrogenated SiGeC (a-SiGeC:H) coatings at 250ºC with well, on nanometer-scale, tailored thickness deposited on large areas as well as on small selected areas (Fig.1b, c) using ArF-Excimer Laser induced CVD is presented and discussed. The irradiation of these films in a single chamber process using the pulsed 193 nm radiation of the same Laser for the dehydrogenation of the amorphous material, the modification to polycrystalline or nanocrystalline films (Fig.2b) or to partially relaxed heteroepitaxial graded alloys on Si(100) wafers (Fig.3b) is also shown and evaluated. Selected samples have been extensively studied through Fourier Transformed Infrared Spectroscopy (FTIR), Hydrogen Effusion Measurements, X-ray Photoelectron Spectroscopy (XPS), Time of Flight Secondary Ion Mass Spectrometry (TOF-SIMS), Rutherford Back Scattering (RBS), X-Ray Diffraction (XRD), Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) as well as Transmission Electron Microscopy (TEM).

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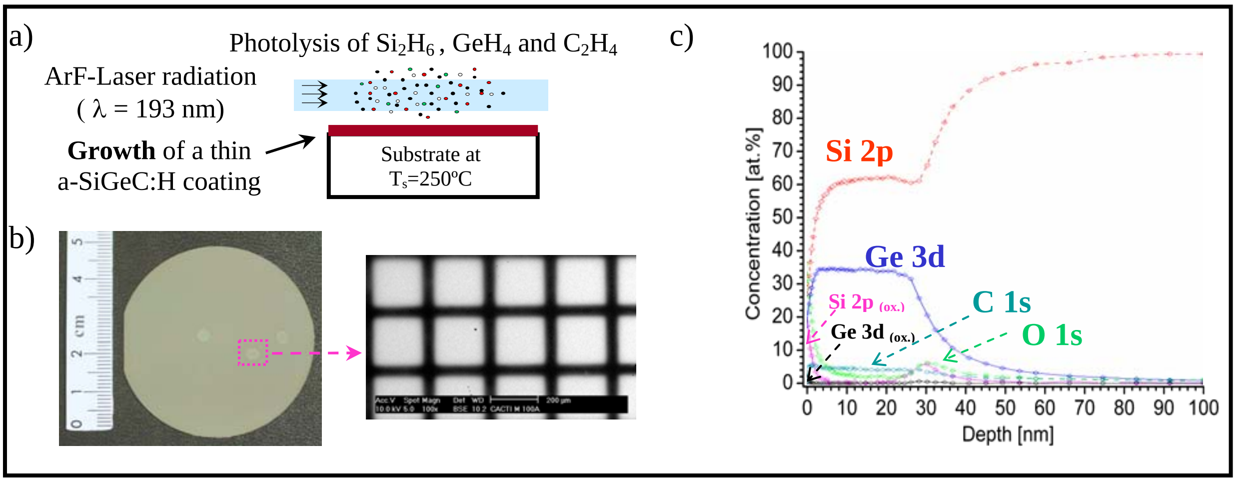

Fig.1 (a) Scheme of the LCVD process, (b) views of uniform coatings deposited on a 2” Si wafer and on selected regions (200 x 200 μm^2 squares), (c) XPS depth profile analysis of an SiGeC films on a thin SiO_2 film

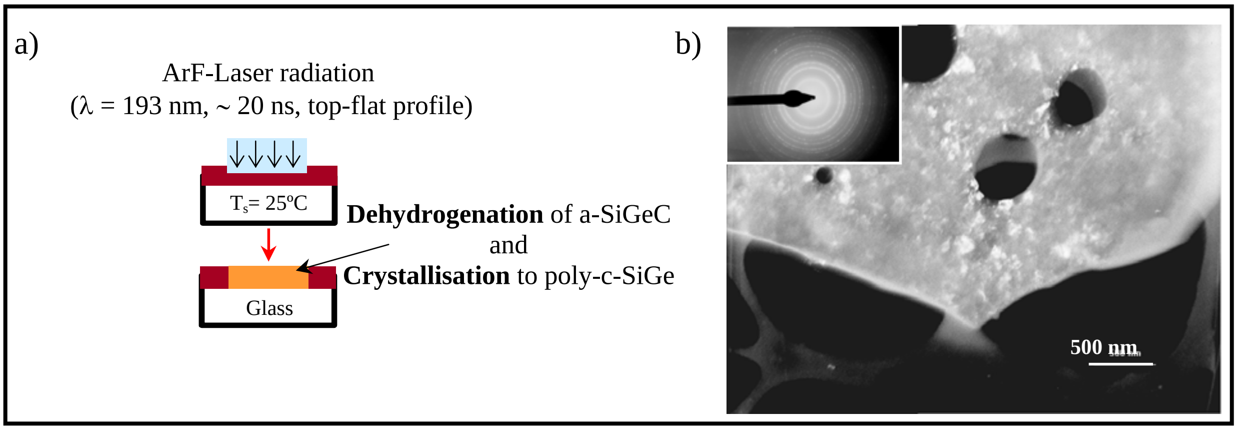

Fig.2 (a) Scheme of the dehydrogenation and the ELC process, (b) TEM electron diffraction and plane view dark field image showing fine grained material (coherence length determined by XRD is 10 – 20 nm).

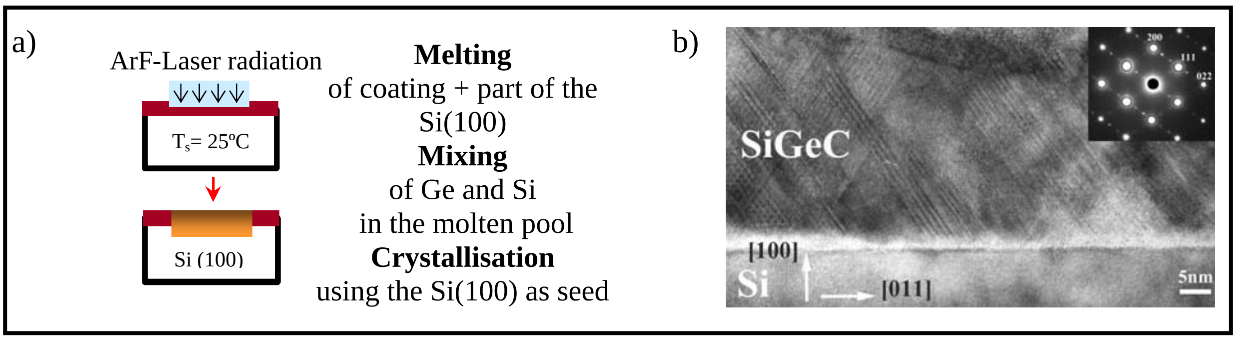

Fig.3 (a) Scheme of the PLIE process, (b) High resolution cross section TEM image of a heteroepitaxial SiGeC film on Si (100), with corresponding electron diffraction pattern.