ICAM 2009
11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25

Raman Spectroscopy Stress Measurements on Atmospheric Plasma Thermally Sprayed pc-Silicon Sheets for Use in Solar Cells Devices

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Abstract – Actually, Silicon is essential input to hi-tech industries[1]. The importance of polycrystalline silicon (pc-Si) being considerate to its application on solar cells as important market product until year 2050[2]. Furthermore, 90% of solar modules between 1998 and 2005 were made with solar cells of crystalline silicon[3]. According to Degoulange *et al*. [4] an increase in the production of silicon for the photovoltaic industry is expected and technologies to produce low-cost silicon with appropriate impurity levels will be needed. There have been interests in developing thick silicon films through plasma spraying technology. The Atmospheric Plasma Thermal Spray (APTS) process proved to be an efficient process to pc-Si silicon sheet deposition [5-8] due to metallurgical grade silicon low-cost, which is marketed in the range of 98 to 99% of purity and due to APTS advantages such as swiftness and low-cost in layers processing [9]. For micro-electronics, it's well known that during and after semiconductors devices processing, mechanical stresses develop in the different films and substrates. Due to this, various kind of problems are associated, such as nucleation and propagation of voids and cracks [10-12]. They may influence dopant diffusion, affect hot carrier degradation and jeopardize the oxide reliability [10-12]. Raman spectroscopy has proved to be very interesting for local stress determination. They can be done at room temperature, in air, without contacts and they are indicated for being non destructive techniques [13-15]. The aim of this work is to characterize APTS silicon sheet Raman spectroscopy to get the APTS silicon sheet mechanical stress values related to the deposition technique at different thickness. For stress determination by Raman spectroscopy, it was made Confocal Raman line maps measurements on the samples, using XYZ stage, focus track function, steps of 0.1 µm, 3 acquisitions each spectrum, with 521cm^{-1} frequency as reference on a Renishaw Invia Raman Microscope [10]. Lorentzian function was fitted for each Raman peak in order to determine the peak frequency. The shift of the 521cm^{-1} frequency value, Δ*ω*, was plotted in function of each sample position were the spectrum was measured. The preliminary results showed the mainly contribution of 2 peaks on Raman spectra attributed to TO and the *Gb* (grain boundary – staking faults) that leaded to crystalline Raman peak broadening toward the low energy side, resulting in asymmetrical peak shape. This asymmetry is associated to a grain size distribution [16,17] that can generate tensile strained microcrystalline Si – Si bonds on crystallite size [13,18,19,20,21,22,23]. The expected results are Raman quantitative values assent for mechanical stress associated to APTS pc-Silicon deposition techniques. This can lead us to find parameters for treatments to promote lattice accommodation and help to develop depositions methodologies to get pc-Si sheets with better micro structures properties such as "splats" adhesion, coalescence and sheet tenacity.

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