IN-SITU MONITORING OF LASER ANNEALING BY MICRO-RAMAN SPECTROSCOPY FOR HYDROGENATED SILICON NANOPARTICLES PRODUCED IN RADIO FREQUENCY GLOW DISCHARGE

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Plasma enhanced Chemical Vapour Deposition (PECVD) has been used to produce amorphous hydrogenated Si nanoparticles (Fig. [1]) of high purity from square wave modulated radio frequency (rf) glow discharges [1, 2] across the flow of argon diluted silane. The samples deposited on glass microscope slides and TEM grids were of various size distributions and [D2]ctures, as determined by the process parameters. Chemical [D3]racteristics, structure [and other information associated with the formation of particular peaks [e then determined through the use of Micro-Raman Spectroscopy. Earlier Raman studies showed particular structural and compositional characteristics of silicon nanoparticles produced by diverse synthesization techniques based on rf glow discharge, electrochemistry, ball-milling, reactive magnetron sputtering and by pulsed laser ablation [3-7].

Micro-Raman back scattering measurements of different coverages of hydrogenated silicon nanoparticles were performed at various CW [D6]r powers (Fig. 2). We present a study of the changing structure of these samples due to the induction of nanocrystallites [D7] the Ar Ion laser when taking the Raman Spectra. As the power of the laser is increased the Si-Si bond vibrational intensity in the Raman spectra also increases with the peak narrowing and shifting to a higher wave numbers which we interpret as further crystallisation taking place as further annealing of the Si:H [urs[D8]. As expected, the intensity is higher for areas with greater coverage of Si: [9]. High resolution transmission electron microscope (HRTEM), electron energy loss spectroscopy (EELS) and selected area electron diffraction (SAED) analysis confirmed the structural changes of [icles[D10], which were associated with the increase of [perature[D11], surface [lation[D12] and hydrogen [diffusion[D13] induced by laser annealing at atmospheric conditions.

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Figures:

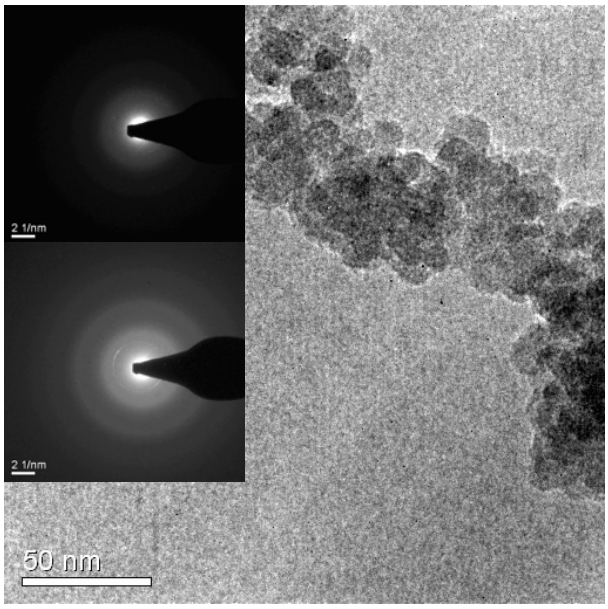

Figure 1: Main Image: TEM micrograph[D14] showing size, relative density and morphology of the Si:H nanoparticles. Upper Inset: SAED image taken far from laser incidence showing the amorphousness of the hydrogenated Si nanoparticles. Lower Inset: SAED image taken on edge of laser incidence, showing some structure of ~3Å.

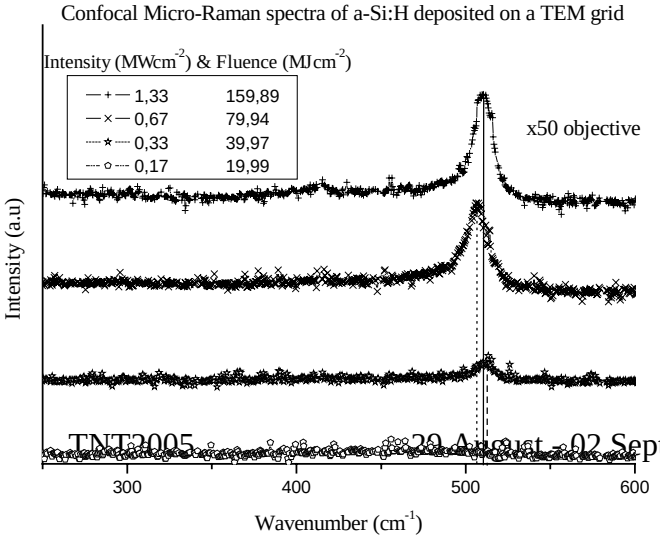

Figure 2: Raman spectra[D15] of the hydrogenated Si nanoparticles, with >2mm separation between lased areas. The peak

at ~500cm^{-1} corresponds to the vibration of the Si-Si bond in Si nanocrystallites.