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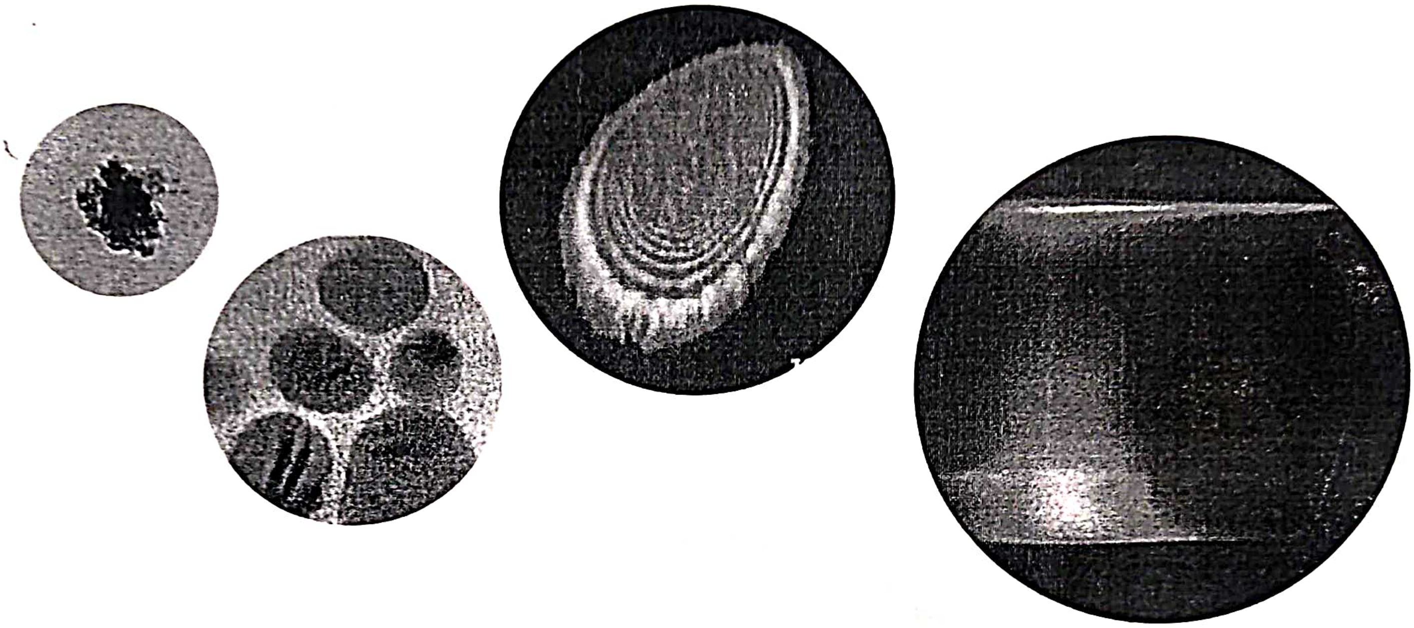

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Amine functionalized water soluble silicon nanoparticles: optical properties

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***Abstract*—Luminescent semiconductor nanoparticles are one of the major areas in nanotechnology as they are resistive to photo-bleaching. Among many nanomaterials, silicon-based nanomaterials show luminescent properties along with stability. These properties can be apt for LED applications and making contrast agents, especially in bio-imaging. Further, the silicon nanoparticles have an advantage of low toxicity. Here we report the hydrothermal route synthesis of amine functionalized silicon nanoparticles and its optical properties. The synthesised silicon nanoparticles are water soluble and exhibit the blue luminescence around the wavelength of 450 nm. The fluorescence lifetime value was found as 5ns.**

***Keywords*— silicon nanoparticle**

1. INTRODUCTION

Luminescent semiconductor nanoparticles are one of the major areas in nanotechnology as they are resistive to photo bleaching. Nano scale silicon particles shows the extensive luminescent properties than its bulk form, especially in the size than 10 nm.[1]. The excellent luminance property, stability and biocompatibility[2] of silicon nano particles prospects its applications from optoelectronics to bio medical field.[3–5]. Numerous methods for synthesising the silicon nanomaterials have been developed such as solution phase reduction method[6], electrochemical etching[4], laser ablation[7], laser pyrolysis[8], plasma assisted synthesis[9] etc.

Here we synthesised silicon nanomaterials by reducing N-[3-(trimethoxysilyl) propyl]-ethylene diamine (DAMO) with trisodium citrate and its basic characterisations were carried out.

2. EXPERIMENTAL

Materials: (3-Aminopropyl) trimethoxysilane (APTMS) ad sodium citrate were purchased from m/s Sigma Aldrich and used without further purifications. De-ionized water was used as the solvent.

Synthesis of silicon nanoparticles (SiNPs):The SiNPs were synthesised by hydrothermal method (fig.1) [10]. 1.2 g sodium citrate was mixed in 25 ml of deionized water and stirred by 30 minutes. 6 ml of APTMS were added to the solution and again stirred up to 30 minutes to get a clear solution. The solution transferred to a 100ml Teflon lined autoclave and kept it at 180 °C for 15 hours. The autoclave allowed to cool in room temperature. A light yellow colored sample obtained. The remaining precursors are removed by dialyzing along with deionized water using 2kDa dialyzis tube. The water removed every 6 hours during 24 hours of dialyzing.

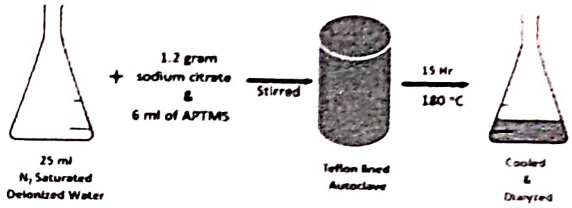

Figure 1. Synthesis of SiNPs

The absorption and fluorescence spectrum of the samples were recorded by using (Jasco V-570) UV–vis NIR Spectrophotometer and Varian Eclipse fluorimeter respectively. Lifetime studies were carried out by Horiba Deltapro™ fluorescence lifetime system.

3. RESULTS AND DISCUSSIONS

Structural Characterisation: In order to confirm the presence of various functional group attached to the SiNPs, FTIR experiment was carried out. Fig. 2 shows the FTIR spectrum of the synthesised sample. As shown in fig 2, the peaks 1140 cm^{-1}, 1035 cm^{-1} and 695 cm^{-1} stands for the vibrations of Si-O groups [11]; Peaks at 3442 cm^{-1} and 1637 cm^{-1} stands for the stretching and bending vibrations of N-H group [12]; The peak at 2930 cm^{-1} and 1390 cm^{-1} positions for stretching and bending vibrations of C-H group [13].

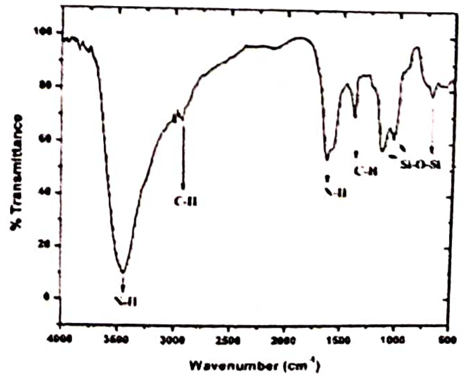

Figure. 2. FTIR spectra of SiNPs

The broad peculiarity between 3000 cm^{-1} and 3600 cm^{-1} indicates the O-H stretching. FTIR spectra show the synthesized SiNPs contains N-H, C-H, OH, and SiO groups.

Optical Characterisations: The absorptions spectrum of the synthesisedSiNPsis shown in figure 3. The absorption peak of the sample isat 349 nm.

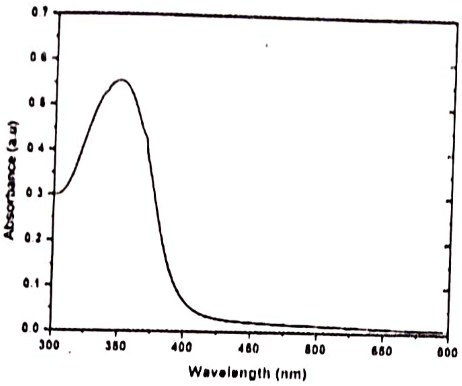

Figure. 3 Absorption spectrum of synthesized SiNPs.

Fig. 4 shows the emission spectra of SiNPs under excitation of 352nm. The sample exhibits an emission peak at 450nm. Inset of the fig. 4 shows the photographs of the SiNPs under visible light (a) and UV illuminations (b). Under UV illumination, the sample exhibits in a bright blue emission.

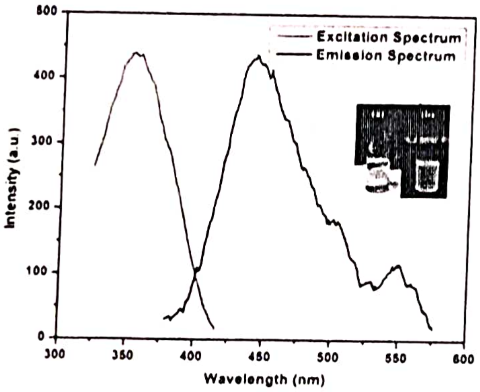

Figure. 4 Excitation and emission Spectra of SiNPs

The fluorescence decay curve is given in the fig. 5. The fluorescence lifetime was measured using time-correlated single photon counting technique (TCSPC). The SiNPs were excited with pulses of wavelength 367 nm and duration 1.4 ns from an LED light source. The fluorescence decay curve is given by

$$F(t) = \alpha_0 e^{-t/\tau}$$

where α_0 is related to the emitting particles of the sample at time t=0, and τ is the lifetime [14] . Fluorescence decay curve fitted by least square curve fitting algorithm and fluorescencelifetime estimated as 5.05 ns. Since the synthesisedSiNPs have longer fluorescence lifetime than the auto-fluorescence of living organisms, it promises for bio-marking applications.

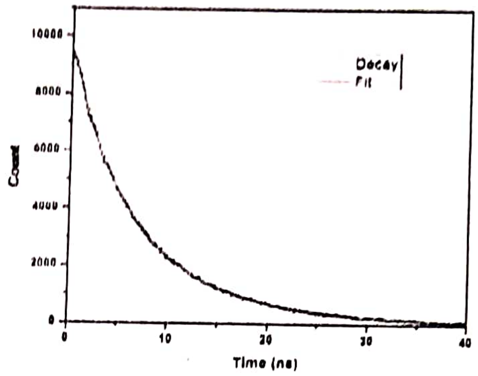

Figure. 5 Emission decay curve and its theoretical fit of SiNPs

4. CONCLUSION

Water-soluble silicon nanoparticles were synthesised by hydrothermal route. The nanoparticles exhibit blue luminescence around the wavelength of 450 nm. The fluorescence lifetime value was found as 5.05ns.This nanoparticle can be used for fluorescence imaging and sensing applications.

5. ACKNOWLEDGEMENT

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