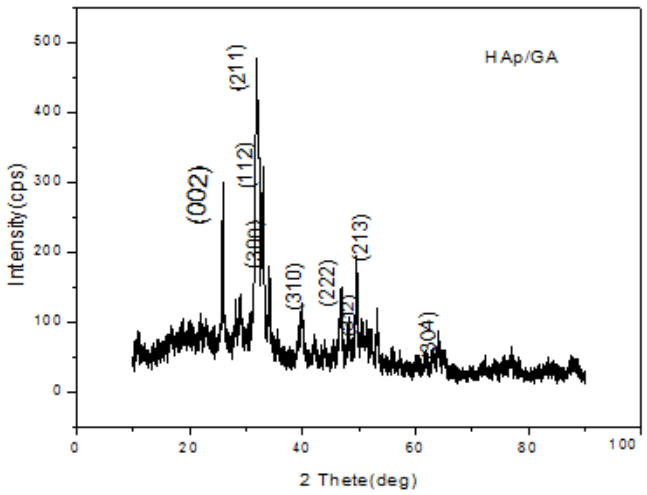

Figure 2: XRD Spectrum for nHAp/GA.

The crystallite size of HAp/GA is determined using the Scherrer formula [8]

$$D = \frac{0.9\lambda}{\beta cos\theta} \quad \text{--- (1)}$$

Where, D is the crystallite size calculated for the (h k l) reflection, λ the wave length of CuKα radiation, β the full width of the peak at half of the maximum intensity and θ the diffraction angle of the corresponding reflection.

The lattice parameters are calculated based on the relationship between lattice spacing (d) and lattice parameters (a,c) of the hexagonal structure, expressed as

$$\frac{1}{d^2} = \frac{4}{3}\left(\frac{h^2+hk+k^2}{a^2}\right) + \frac{l^2}{c^2} \quad \text{-- (2)}$$

The Fraction of Crystallinity (X_c) of the HAp/GA nanoparticles are calculated from the equation.[9]

$$X_C = \left(\frac{0.24}{\beta}\right)^3 \quad \text{--- (3)}$$

Specific surface area of the HAp/GAis determined by the formula

$$S = \frac{6\times10^3}{d\rho} \quad \text{--- (4)}$$

Where ρ is the crystallite Size (nm) and d is the theoretical density of HAp (3.16 g/cm^3).
The micro strain (ε) is calculated using the relation.[10]

$$(\varepsilon) = \frac{\beta\ cos\theta}{4} \quad \text{---- (5)}$$

The value of dislocation density (δ) is calculated using the relation.

$$(\delta) = \frac{1}{D^2} \quad \text{---- (6)}$$

The u-parameter valueiscalculated using the relation.[11]

$$u = \left(\frac{a^2}{3c^2}\right) - 0.25 \quad \text{--- (7)}$$

The unit cell volume (V) is determined by the relation.[12]

$$v = 0.865a^2c \quad \text{--- (8)}$$

The standard lattice constant a = 9.418 Å and c = 6.884 Å (JCPDS card no.09-0432) for the HAp has been matched well with the obtained values a = 9.370 Å and c = 6.889Å.

Unit cell volume and u parameters values are 523.180(Å)^3 and 0.3829.

Crystallite size, Fraction of Crystallinity, specific surface area, dislocation density, microstrain values are given table 1 and 2.

Table 1:2θ, FWHM, Miller induces value and Crystallize Size for nHAp/GA.

2θ	FWHM	h k l	Crystal size (nm)
25.869	0.211	0 0 2	6.7399
31.928	0.48	2 1 1	3.0034
49.54	0.33	2 1 3	4.6260

Table 2: Specific surface area, Micro Strain and dislocation density, Fraction Crystallinity for nHAp/GA.

Specific surface area(m^2/g)	Micro strain($10^{-3}lin^2m^{-4}$)	Dislocation density(10^{-15} lin/m^2)	Fraction of crystallinity
281.71	0.0514	0.0220	1.4715
632.19	0.1153	0.1108	0.125
410.44	0.0749	0.0467	0.3846

4.3 TEM

The morpology, particle size and pores have been investigated through TEM analysis. Figure 3(a)(b)(c) shows the TEM image of HAp/GA powder. The micrographs reveal the formation of rod-like shaped morphology of the particles in the powder sample. At room temperture, the powder sample consists of rod-like particles with length in the range 160 – 247nm. The existence of pores and their disordered arrangement were displayed in the figure.Although it was not possible to calculate the exact pore size from TEM image due to the low resolution. SAED pattern are shown in figure (4). SAED of the precipitates shows diffraction ring of patterns, which implies that the precipitates are crystalline in nature. This is agreed with XRD result and confirmed the nanosize componentts of nHAp/GA nanocomposite.

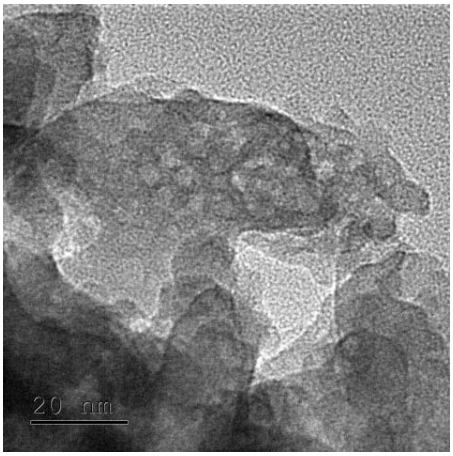

Figure 3:(a) TEM image for 20nm.

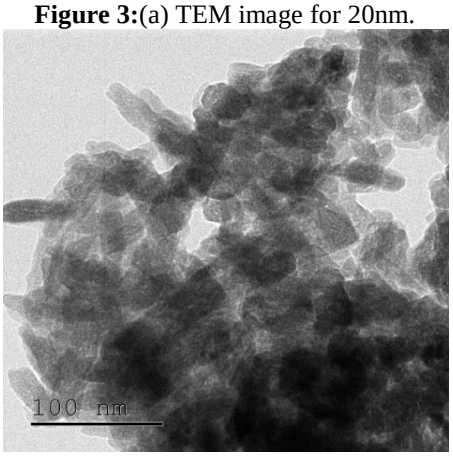

Figure 3(b): TEM image for 100nm.

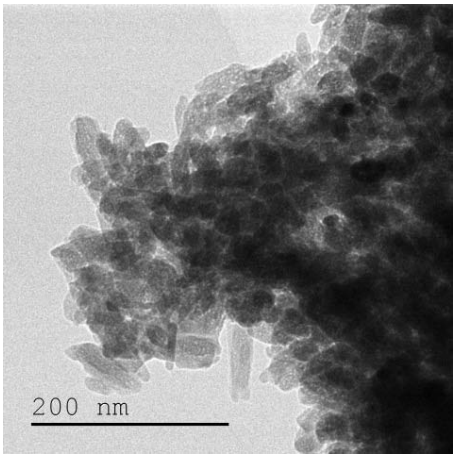

Figure 3(c): TEM image for 200nm

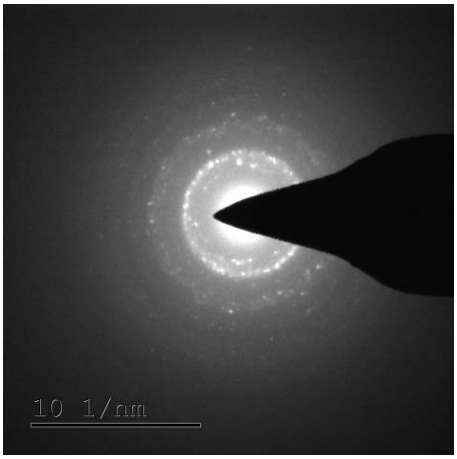

Figure 4: SAED pattern for nHAp/GA nanocomposite

4.4 Thermal analysis

The decomposition behavior of nanoHAp/GA composite is shown in fig(5). The nanoHAp/GA is calculated from the residual weight in TGA curves at 600˚C. However, since it is very difficult to control adsorbed water content in the composite, this nanoHAp/GA content is only an approximate value. A small decrease in weight, is associated with adsorbed water-removing when heated above 90˚C. The quick weight loss is observed from about 280˚C to 600˚Candbeyond 600˚C to 800°C no significant wt.loss was observed. The stable curve was noticed within this temperature range, which indicates thermal stability of HAp/GA powder. DTA curves shows endothermic peaks at 330˚C which are due to thermal degradation.

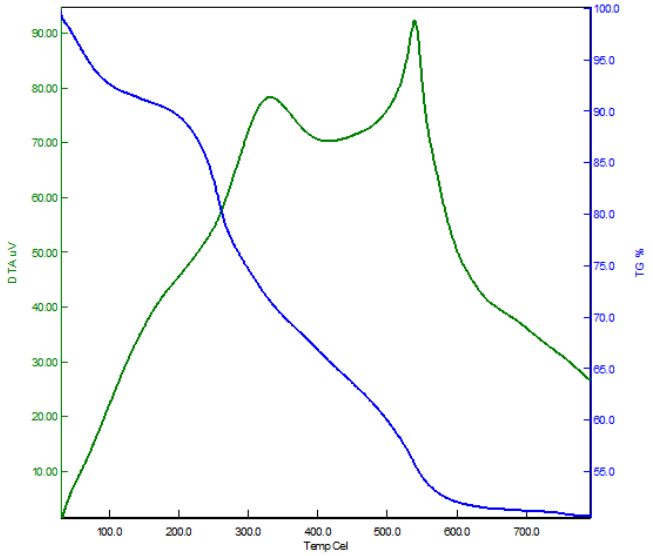

Figure 5: TG/DTA for HAp/GA nano composite

5. Conclusion

nHAp/GA composite were synthesized by modified wet chemical method. At room temperature and characterized by powder XRD, FTIR, TG/DTA and TEM. FTIR result conforms functional group like(O-H),(P-O),(C-O). The XRD, SAED patterns conform that hydroxyapatite has nano size of crystalline nature of the sample. TEM result suggests that the stoichiometric nHAp/GA exhibit particle with nanorod like morphology. SAED pattern are in good

Agreement with XRD Thermal properties of the material are assigned by TG/DTA analysis.The crystallite size, lattice parameters, specific surface area , volume density, micro strain, u parameter and dislocation density also measured by using XRD data. Nano materials are greatly promising in the development of more valuable orthopedic and dental implants. The result indicated that the composite material was expected to find application for bone repairing.

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