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″Biomimetic synthesis of calcium phosphate and TiO_2 nanomaterials nanocomposites″

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Biomimetic synthesis of calcium phosphate and TiO_2 nanomaterials nanocomposites

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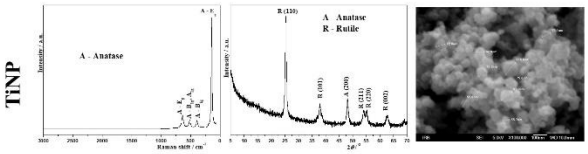
INTRODUCTION

Modern lifestyle and increased life expectance result in increased frequency of different chronical diseases among which special place take hard tissues diseases. Often the only treatment of such diseases is implantation with the aim to regenerate damaged or diseased tissue. Novel hard tissue regeneration biomaterials emerging in recent years are composite materials based on calcium phosphates (CaPs) and different inorganic nanomaterials. In this sense TiO_2 nanomaterials (TiNM) attract special attention, as they can improve short-term mechanical strength of CaP biomaterials. In order to determine the relationship between NMs interface properties (surface modification, morphology, surface charge density, crystal structure) and the properties of forming CaPs solid phase at conditions close to physiological, in this research, the influence of two morphologicaly different TiNMs, nanotubes (TiNT) and nanoparticles (TiNP), on spontaneous CaP formation was studied.

SYNTHESIS AND CHARACTERISATION OF TiNM

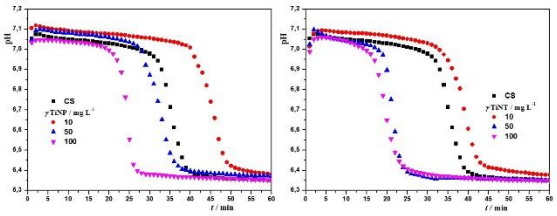
- TiNP were purchased from Sigma-Aldrich and TiNT were prepared using a chemical process similar to that described by Kasuga and co-workers[1].
- 2.5 g of TiO_2 P25 were suspended in 65 mL of 10 mol dm^{-3} NaOH.
- The suspension was placed in Teflon autoclave of 100 mL capacity, sealed into stainless steal tank and maintained at 140 °C for 48 h.
- After the autoclave was cooled to the room temperature, the obtained sample was sequentially washed with 0.1 mol dm^{-3} HCl aqueous solution, distilled deionized water and absolute ethanol for several times.
- The samples were dried at 100 °C for 8 h. Finally, soft fibrous white color powders were obtained.

[1]T. Kasuga, M. Hiramatsu, A. Hoson, T. Sekino, K. Niihara, *Adv. Mater.* **15** (1999) 1307.

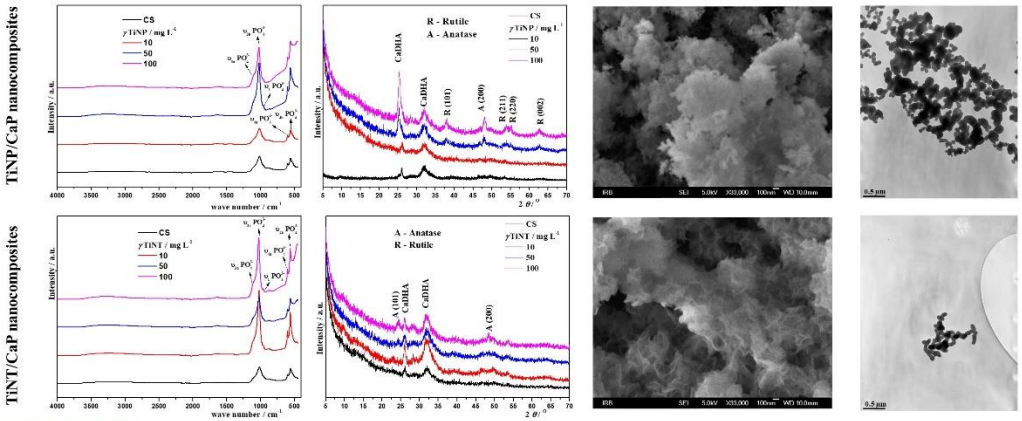


INFLUENCE OF TiNM ON SPONTANEOUS CaP PRECIPITATION

- The precipitation systems (CS) were prepared by fast mixing of equal volumes (20 mL) of equimolar $CaCl_2$ (cationic) and Na_2HPO_4 (anionic) solutions. The initial concentration of anionic and cationic components in all precipitation systems were 4 mmol dm^{-3}.
- TiNP/TiNT were added in anionic component and pH was adjusted to 7.4 with HCl acid. The concentrations of added TiNM are 10, 50 and 100 mg L^{-1}.
- All experiments were performed at (25 ± 0.1) ºC in a thermostated double walled vessel.
- The reaction was followed by monitoring pH changes within the dispersion unit (Metrohm 701 pH/ion meter). Based on pH vs time curves, induction time for amorphous calcium phosphate (ACP) transformation were determined. Samples for further analysis were taken after 60 minutes.



γ TiNM / mg L^{-1}	0	10	50	100	
t_{ind} / min	29.4 ± 3.2	34.2 ± 6.7	28.4 ± 0.8	22.4 ± 1.2	*TiNP
		35.8± 3.1	17.43 ± 1.0	17.9 ± 2.0	*TiNT



CONCLUSION

Preliminary results showed that TiNP and TiNT affects precipitation and transformation of CaP. Both TiNM exhibited dual influence on precipitation kinetics, i.e. inhibition at lower concentrations and promotion at higher concentrations, contrary to the influence that organic flexible polyelectrolytes exhibit. No significant differences in composition and morphology of formed precipitates were observed, as deficient calcium phosphate (CaDHA, $Ca_{10-x}(HPO_4)_x(PO_4)_{6-x}(OH)_{2-x}$, $0 < x < 2$) was obtained in the presence of both TiNM. CaDHA is considered to be a very promising material for manufacturing hard tissue regeneration materials because, as biological apatite, the main inorganic part of animal hard tissues is in fact ion-substituted CaDHA.

Obtained results can serve as basis fot developing biomimetic routes of CaP/NM nanocomposites synthesis.

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