2510

Gold Titanate Nanoparticles – Synthesis, Properties & Applications

D.C. Chan*, Dept of Restorative Dentistry, A. Paranjpe, Dept of Endodontics, Health Sciences Center, University of Washington, Seattle, Washington, UNITED STATES; K. Taylor-Pashow, Savannah River National Laboratory, Aiken, South Carolina, UNITED STATES; & T. Eiampongpaiboon, Department of Prosthodontics, Faculty of Dentistry, Mahidol University, Bangkok, THAILAND.

Objective: The aim of this study was to customize the properties of nanoscale gold titanates through a sol-gel process and the characterize the resulting nanoparticles and investigate their potential antimicrobial applications.

Methods: Two synthetic strategies, sol-gel and hydrothermal, were employed to produce nanoscale gold titanates. Methodologies have been previous discussed. Briefly, the hydrothermal synthesis entailed adding 1.875 g of TiO_2 powder to 150 mL of 10 M NaOH and the resulting mixture was vigorously stirred for 1 hour. The reaction mixture was then heated in a pressure reactor at 110° C for 24 hours. The formation of sodium titanate nanotubes of the form Na Ti O (OH) ensues by self-assembly of the dissolved intermediate of TiO_2 and NaOH. The resulting suspension was then cooled to room temperature and filtered. The solids were washed with ultrapure water (MilliQ Element) to a pH of approximately 9 before drying in air. Nanoscale particles of monosodium titanate (MST) were prepared by a proprietary process adapted from the previously published sol-gel process for the preparation of micron-sized MST. Particle morphology and size for both synthetic strategies were verified with SEM, TEM and EDX.

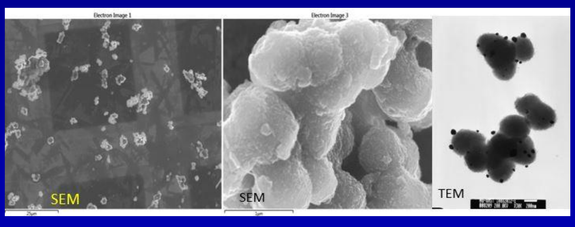

Figure 1. SEM and TEM micrographs of Au titanate nanoparticles

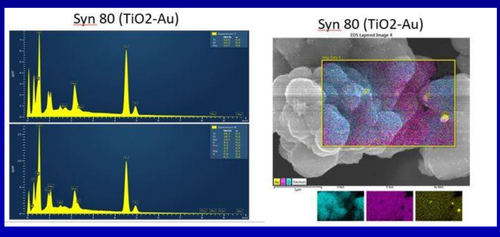

Figure 2. Elemental and EDX overlay of various major elements

Figure 3. Possible applications of Gold-Titanate Nanoparticle in dental treatments include incorporation into restorative materials (a-c). However, esthetic considerations limit its potential use to endodontic intracanal application (d). Its most promising use will be as an antimicrobial coating for implants because of its compatibility with titanate (e).

Au Loading in digested sample

	[Na] (mg/L)	[Au] (mg/L)	[Ti] (mg/L)	Ti:Au ratio	g wet sample (g)	Au loading (mg/g moist solid)	wt % sample (TGA)	g dry sample	Au loading (mg/g dry sample)	g Au/g dry sample	g Au/g wet sample
Au-nMST-Syn 81	24.8	40.4	217	5.37	0.04	10.07	11.89%	0.005	84.67	8.47E-02	1.01E-02

Table 1: Au Loading (mg/g) Dry Sample

Result: Au loading of the digested samples is illustrated in Table 1. Titanates occur as roughly spherical particles with diameters of 1-10 µm. Minimal agglomeration is evident from the SEM and TEM images shown (Figure 1). Elemental analysis and EDX overlay of different elements is shown (Figure 2). It has been shown that Au titanate complexes effectively inhibit growth of oral bacteria as these nano-particulate complexes have a high surface-to-volume ratio, resulting in effective ion-exchange characteristics.

Conclusions: The nanoparticles can be produced by the methods that we proposed. One of the shortcomings of the metal titanate materials can be turned around to be its advantage. Metal titanates are known to discolor due to the ease of re-dox reactions (Figure 3). Their applications in direct restorative materials is thus limited. However, the compatibility of metal titanate with titanium implants actually make them a useful coating as a weapon to fight peri-implantitis.

This study is supported by WDS Endowment.