Template Free Growth of Novel Hydroxyapatite Nanorings: Formation Mechanism and their Enhanced Functional Properties

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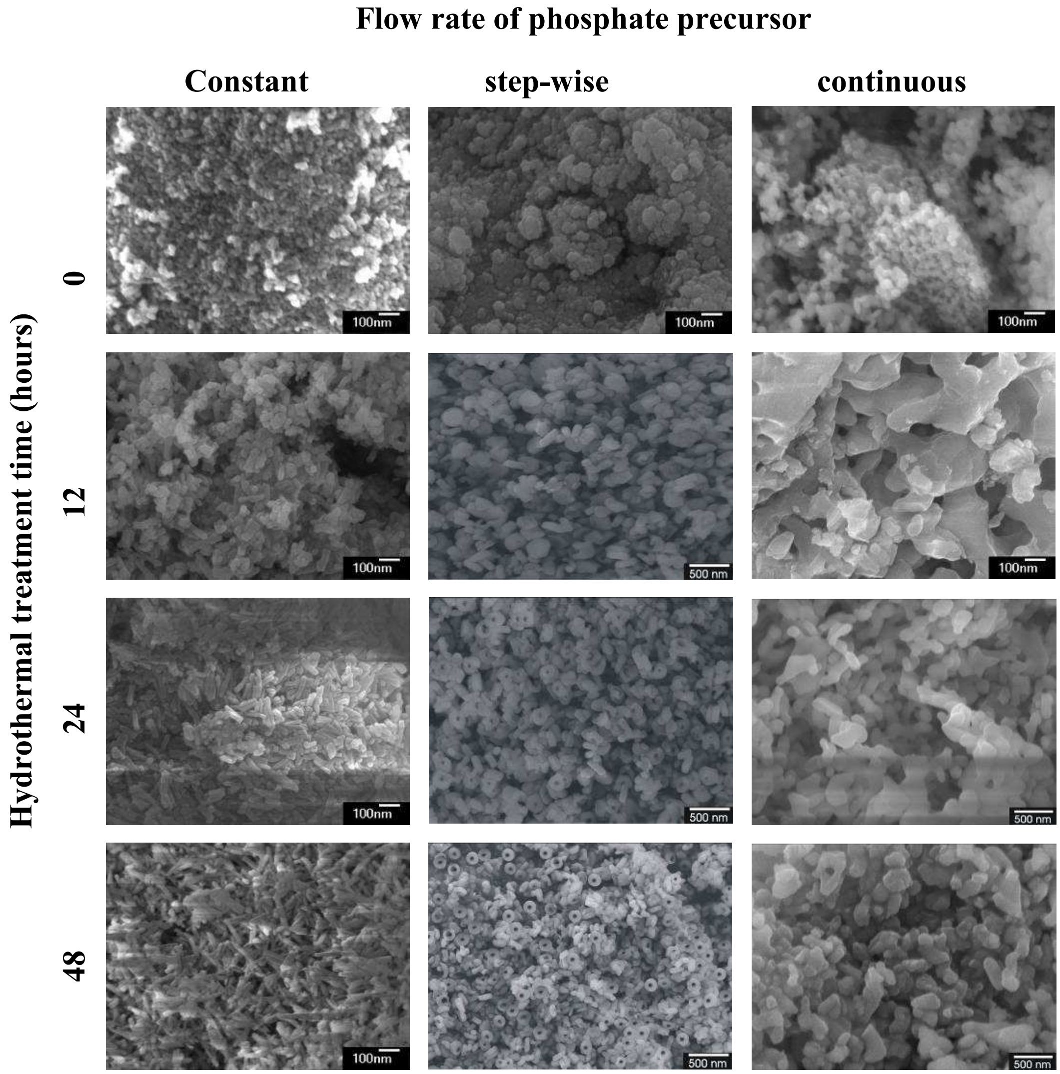

Figure s1: FESEM images of nanoparticles prepared with different conditions

BET specific surface area analysis:

Nitrogen adsorption-desorption isotherms of the present study were obtained using Autosorb-1 (Quantachrome Instruments). Samples were out gassed at 110°C under 10^{-2} mmHg for more than 6 h prior to measurement. Specific surface area was calculated by BET (Brunauer-Emmett-Teller) method using adsorption isotherms. Pore size distribution was calculated by BJH (Barrett-Joyner-Halenda) method using desorption isotherms.

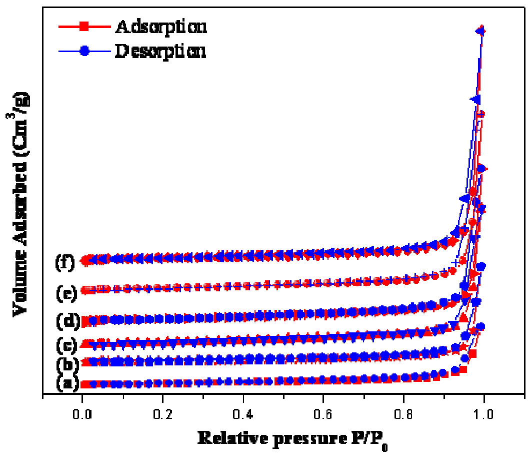

Figure s2: Adsorption-desorption isotherms of (a) coarse crystals (b) nanodisks (c) partially etched disk (d) nanorods (e) nanospheres and (f) nanorings.

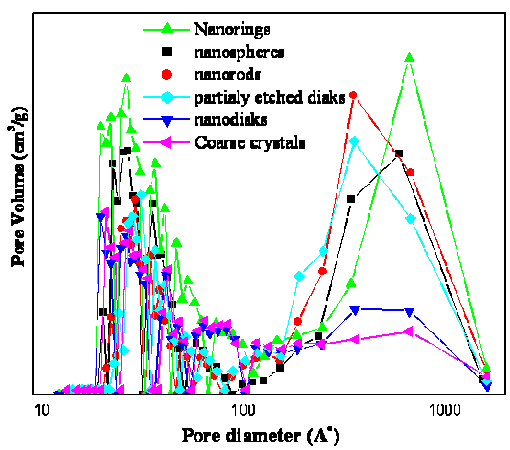

Figure s3: Corresponding pore size distribution of Figure s2.

Table s1: Specific surface area and pore volumes of different nanostructures in this study

Sample	Specific surface area (m^2/g)	Pore volume (cm^3/g)
Nanorings	89.62	0.3124
Partially etched disk	58.24	0.1521
Nanodisks	46.32	0.1062
Nanorods	66.74	0.2194
Nanospheres	78.91	0.2412
Coarse crystals	31.21	0.1011

The fracture strain of HWMPE/Hap nanocrystals was plotted against the specific surface area in figure s4. In HWMPE matrix composite reinforced with plate shaped Hap crystals such as disks, partially etched disks and nanorings, the fracture strain increased with increase of the specific surface area. The figure also suggests that the shape of HAp crystals also have an influence on the ductility of composites. Since the surface to volume ratio is the lowest for sphere-shaped crystals, the crystal volume for a nanosphere crystal at the same specific surface area would be highest, which would aggravate the mechanical performance. Compared to smooth spherical particles, the tiny particle with irregular shape is more preferable since the molten polymer can penetrate into troughs on the particle surface during high temperature processing route resulting in mechanical interlock between HAp and HMWPE, in addition to any chemical bonding. The same interlocking mechanism is believed to takes place in the case of nanorings/polymer composite.

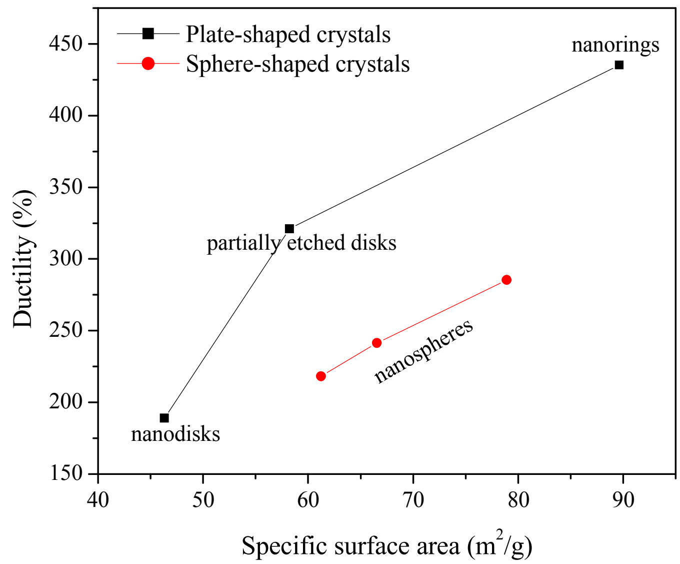

Figure s4: Relation between SSA and ductility of HMWPE composites reinforced with plate-shaped HAp nanocrystals (disk, etched disk and ring) and sphere shaped HAp nanocrystals with different size (data from our previous work about HAp nanospheres; *Chem. Eng. J. 173 (2011) 846-854*)

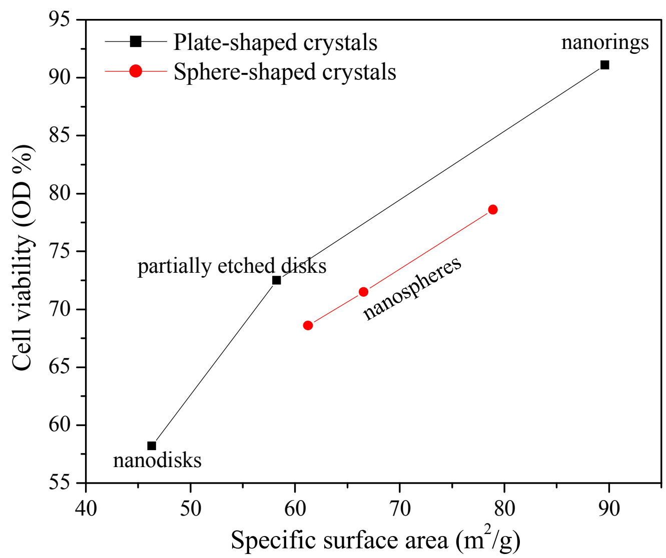

Figure s5: Relation between SSA and cell viability (optical density) of HMWPE composites reinforced with plate-shaped HAp nanocrystals (disk, etched disk and ring) and sphere shaped HAp nanocrystals with different size.

Cell viability percentage is also plotted with respect to the specific surface area in figure s5. The figure shows that cell viability increased with increase of the specific surface area. Many reports suggest that the larger surface area allows enhanced adhesion of cell, protein and drugs. Along with their larger surface areas, their hollow interior structure allows external agents to be encapsulated inside, enhancing the biological cell activity.