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DEGRADATION PROPERTIES OF NANOPOROUS CARBONATED HYDROXYAPATITE IN PHOSPHATE BUFFER SALINE

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1. INTRODUCTION

Biomaterials are classified into bioinert, bioactive and bioresorbable materials based on the tissue reaction towards the materials. Zirconia, stainless steel, titanium and aluminium are some examples of bioinert materials and they are good for implant application. Meanwhile hydroxyapatite, bioactive glass, and glass ceramic are some examples of bioactive materials. Most of these materials are used as substitute materials and implants in orthopaedic and dental applications. On the other hand, bioresorbable materials are used for bone scaffold and drug delivery application. The example of bioresorbable ceramics are calcium carbonate, carbonated hydroxyapatite, tricalcium phosphate and calcium sulphate dehydrate. The similarity between bioinert and bioactive ceramics is that both exist in the human body for life.

Hydroxypatite (HA),$Ca_{10}(PO_4)_6(OH)_2$, a calcium orthophosphate bioceramic that is widely used in the biomedical world. HA is famous due to its magnificent biocompatibility with human tissues. HA is the main component in hard tissue.

There are several HA uses, for example, it is used for bone regeneration, as a filler to replace amputated bones and a coating to promote bone ingrowth into prosthetic implants. HA is a natural form of calcium hydroxyapatite with its formula as $Ca_5(PO_4)_3(OH)$. HA is a promising drug carrier but due to its low resorbable properties, it experience burst release and unsustain drug release. Chemically, CHA shares similarities with the main mineral components of natural bone. The carbonate content in bone mineral is about 4 wt. %–8 wt. %. Carbon causes a decrease in crystallinity and an increase in solubility for both in vitro and in vivo tests when it is present in appatite lattice. Therefore, due to the presence of carbonate ion in CHA structure, it has demonstrated better resorbability properties as compared to HA. The International Union of Physical and Applied Chemistry (IUPAC) released the standard definition of pore size right in 1994, as in Figure 8.1, which defines that microspores are pores that are smaller than 2 nm in diameter, mesoporous are 2 nm to 50 nm, and macrospores are larger than 50 nm. Since the nanotech emergence in 2000, micro, meso, and macrospores can also be described as nanopores, because their pore sizes are between 1 nm and 100 nm, which fall into the nanoscale range.

Since the material pores are suitable for carrying substances, porous HA is expected to be a magnificent drug carrier [1]. The nanoporous material is used as a drug carrier due to the nanoporous material size which lies between 1 nm – 100 nm. It is very suitable as a drug carrier because drug size is similar or smaller than the pore size [1]. However, HA lacks in terms of resorbability and biodegradability as compared to Carbonated Hydroxyapatite (CHA).

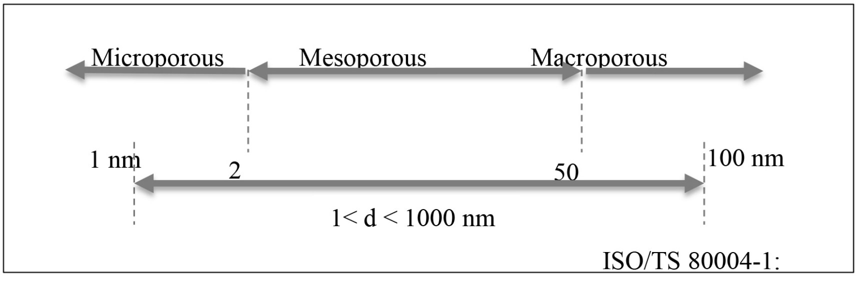

Figure 8.1. IUPAC Classification Class of Porous [13].