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CALCIUM PHOSPHATE BIOCERAMICS

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INTRODUCTION

Since Dreesman applied calcium sulphate (plaster of Paris) as a bone substitute in the last century (1894), interest in ceramics consisting of physiological salts has been increasing to a point where they are clinically applied in a growing number of surgical disciplines. Several review articles have appeared recently (de Groot, 1981; Jarcho, 1981) and it suffices therefore to mention that the two calcium phosphate minerals apatite and β -whitlockite have been studied most.

Although chemically pure β -whitlockite is not thermodynamically stable in aqueous solution, it can be formed at higher temperatures. 'Impure' whitlockites, however, may be formed under physiological conditions. At temperatures higher than about 800°C, a calcium phosphate salt with $\text{Ca/P} = 3/2$ will undergo a phase transition from apatite to β -whitlockite, while a salt with $\text{Ca/P} = 5/3$ when heated to this temperature, will keep its apatite lattice.

At present, calcium phosphate ceramics can be produced with a wide variation in mechanical and biological properties. We will see that compressive strengths up to 490 MPa, and a tensile strength of about 98 MPa are easily obtained with densely sintered ceramics (Driessen et al., 1982). Fatigue failure, a general drawback of ceramics, can be prevented by continuously precompressing the ceramic device (de Putter et al., 1983). Several laboratories, including our own, are trying to develop fatigue resistant coatings of apatite, which would greatly increase the number of applications (for example, apatite coated cementless hip joints). No reliable coating has been reported yet, however. Manipulating porosities and/or crystallographic lattices allow the biodegradation rate to be predictable; varying from unmeasurable to 10% or more per month. Recent data, however, suggest that biodegradation of calcium phosphate ceramics may lead to particle deposition in neighbouring lymph nodes, a phenomenon that needs further study (Klein et al., 1983).