CHAPTER V

CONCLUSION

This study of strength properties of cattle bone materials using the indentation method is divided into three main parts ;the preparation and characterization of cattle bone material, the observation of Vickers - produced deformation / fracture pattern on cattle bone material surfaces, and the determination of strength of cattle bone material. In the first part (Chap. 2), the characteristics of cattle bone material are studied as a function of sintering process variables, i. e. temperature and time. A minimum grain size of 0.6 μm is obtained at sintering temperature of 1250° C, and a maximum grain size of 6.0 μm is obtained at sintering temperature of 1345° C. By the means of normal sintering process, the highest density of 94.2 % of the theoretical density can be achieved from the cattle bone material fired at 1345° C for 3 hrs.

From the observation in the second part (Chap. 3), Vickers - produced damage patterns on cattle bone material surfaces are found to consist of a central deformation zone accompanying by the two crack systems : (i) the median/radial crack forming on the two mutually orthogonal median planes of symmetry defined in each case by the indentation axis and one of the impression diagonals centered on the contact point, (ii) the lateral cracks forming nearly parallel to the surface and centered beneath the contact zone. The damage is visible on the surface as radial crack traces emanating from the impression corners. The lateral crack which is less penetrative than the median/radial crack is of minor consideration in this thesis. Impression half - diagonal a and radial crack length c in cattle bone material are found to depend upon the 1/2 and 2/3 power of indentation load P, respectively. The hardness H, which is ralated with a mean value of Pa^{-2} according to the Eq. (3.4) is thus obtained to be 0.93 GPa for cattle bone material. The toughness, which is related with a mean value of $Pc^{-3/2}$ according to the Eq. (3.7), is obtained to be 0.07 MPa. $m^{1/2}$. An additional point of importance in this part is that the cattle bone material is found to be highly susceptible to moisture - assisted slow crack growth.

From the last part which deals with strength of cattle bone material (Chap. 4), we found that the microstructure is indeed be an important factor in characterizing the strength of cattle bone material. By the use of indentation method, sizes of strength - controlled crack can be varied systematically via the contact load, thereby allowing for controlled progression from macroscopic to microscopic crack domains. Therefore, characterization of microstructure - strength properties can be made with optimal simplicity and economy. Two quantities are required to specify the strength behaviour of cattle bone materials. One relates to the macroscopic toughness determined from large - scale crack specimens and the other to a microstructure - associated stress intensity factor. The first quantity, macroscopic toughness K_c^{∞}, evaluated from the strength data in the indentation - controlled region, are found to be 0.20 and 0.18 MPa $m^{1/2}$ for cattle bone materials with

0.6 μm and 6.0 μm grains, respectively. The second quantity, the threshold indentation load P^*, are found to be 2 and 8 N for cattle bone materials with 0.6 μm and 6.0 μm, respectively. Therefore the transition from indentation - controlled behaviour to microstructure controlled behaviour is more pronounced in the 6.0 μm grain size than 0.6 μm grain cattle bone materials. The study emphasizes the need for extreme caution in extrapolating macroscopie - crack data unconditionally into the microscopic crack region.