Bovine bones as raw material for biomedical application by additive manufacturing

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Bovine bones are composed of inorganic (60-70 w%) and organic (20-30 w%) parts, as well as a few percent of water (5-10 w%). The inorganic matrix is essentially composed of hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$). It is therefore a compound of interest for biomedical applications, notably as a bone substitute. Several studies are looking into the possibility to dope hydroxyapatite with cations such as magnesium and sodium, or anionic groups such as carbonates, which are known to enhance the bioactivity of bone substitutes. However, all these doping agents are naturally occurring in bones. As a result, it could be interesting to valorize bovine bones from the food industry, which represents 130 billion kilograms of waste per year.

Currently, the conventional method to recover hydroxyapatite from a bone matrix is to burn it at high temperature to degrade the organic part into CO_2. However, the disadvantages of this method are that it is an energy-consuming process, producing CO_2, which is a greenhouse gas. Moreover, it degrades the carbonates naturally occurring in bones. Therefore, we have developed a method that reduces CO_2 emissions by degrading the organic matrix into water-soluble molecules, while preserving the carbonates.

In addition, we considered the possibility to use the recovered hydroxyapatite powder in additive manufacturing by stereolithography, to produce parts with a pore volume similar to cancellous bone (75 vol%).