Potential of Magnesium Composite Orthopedic Foams
Optimized for Bone Regrowth

Thomas Brzozowski

Introduction
Magnesium metal is a promising biomaterial for orthopedic implants due to its similar mechanical properties to bone, bone regeneration assistance, and non toxic filtration out of the human body. However, the corrosion rate in the human body is too quick for a fully dissolvable orthopedic implant. A comprehensive literature review of current corrosion control methods of magnesium was performed. This included alloying methods, coating methods, and magnesium composite structures. Of the aforementioned methods, a syntactic magnesium-hydroxyapatite composite foam showed the most potential. Through further testing and successful optimization of these magnesium-hydroxyapatite foam structures, the prospect of calculated corrosion and assisted bone regrowth in magnesium orthopedic implants becomes possible.

Mg-HA Syntactic Foam
Methodology
In a study at Shanghai Jiao Tong University in Shanghai, a syntactic composite foam made from AZ91 magnesium alloy and Hydroxyapatite was created. Hydroxyapatite was chosen as the bio ceramic due to its chemical and structural similarities to bone. The Foam is synthesized using a squeeze casting method. First, A cluster of 600 µm spheres using PMMA (polymethylmethacrylate) material are grouped together and chemically bonded with acetone. Next, the structure was filled aqueously with HA powder and dried into a plaster mold. The system is then put in a furnace and heated to 220 degrees Celsius (30h) and then 400 degrees (5h) to burn away all the PMMA material. Where the balls were chemically welded together, a porous preform structure now remains. The ceramic was then heated to 1115 degrees Celsius (30h) and then 400 degrees (5h) to burn away all the PMMA material.

Results

Function
Figure 5: Graphic showing the function of the AZ91-HA syntactic foam. (a) bone cells attaching and growing on the surface of the implant. (b) magnesium is pouring on the preform structure. (c) Remaining HA scaffold is completely filled with newly restored bone, resulting in fully healed bone.

Conclusion
In conclusion, The potential for magnesium composite foams are promising. Its design is versatile, with choices of pore size, mg alloy type, as well as bio ceramic type. By further researching what types of magnesium alloy slow corrosion, this implant can be tested thoroughly to calibrate an ideal corrosion rate. The implants key idea is that it fully dissolves and is replaced by bone tissue. It is the timing of this process that needs calibration. It is also made up of safe biomaterials that the body can deal with naturally.

Currently, further testing of mechanical properties along the corrosion curve is needed. In depth testing the bone regeneration is also essential, though the bone promoting properties of both magnesium and hydroxyapatite are promising to this key aspect. Through further fabrication and testing of magnesium syntactic foams like the one from the study in Shanghai, it may be possible to speed up the body’s natural healing process in a safe way for larger fractures that would usually take months to heal.