Application of Ti and Mg hybrid material as partly degradable implant

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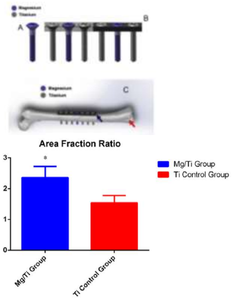
Advantages of combination Ti and Mg

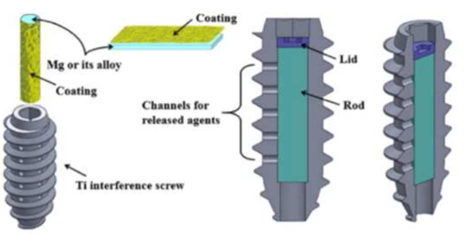
-Strength, stability and corrosion resistance of Ti
-Biocompatiblity, bone stimulatation and antibacterial properties of Mg

New class of implants:

Hybrid fixation system & interference screw



Tian L., et. al. Biomaterials 180 (2018) 173



Luo Y., et. al. Bioactive Materials 6 (2021) 3231

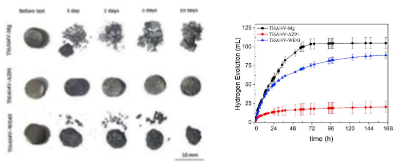
Requirements&challenges

Strong connection ⟷	**low solubility of Mg in Ti**
Prohibited exchange ⟷	**limitation of alloying atoms (Al)**
Low Mg degradation ⟷	**large difference between electrical potential of Mg and Ti**
Bioactivity of Ti ⟷	**H_2 penetration (hydrogenation)**
Stability of Ti ⟷	**Formation of Ti hydrides**

Pure Mg, 99.5%

AZ91 (Mg-9Al-0.8Zn-0.2Mn)

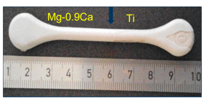
WE43 (Mg-4Y-3RE-0.5Zr)

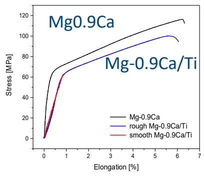


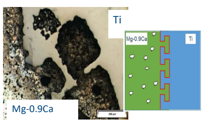
Z. Essen et. al. Corrosion Science 166 (2020) 108470, E.-S. M. Sherif et.al. Materials 12 (2019) 1300

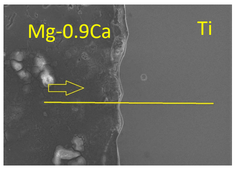
Connection of MgxCa and Ti via MIM&Sintering

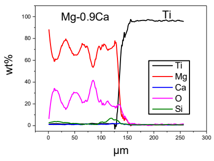
„Undercuts" formation & no transfer of Ti into MgxCa





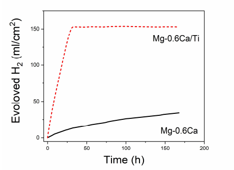




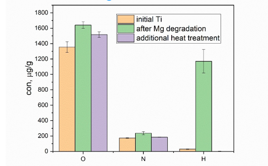


V. Haramus, Th. Ebel, N. Ramakrishnewgowda, S. Bußacker, J. Schaper
Method fort Producing a Metallic Implant, European Patent EP 3524280B1, Issued 08.01.2020

Fast degradation of Mg

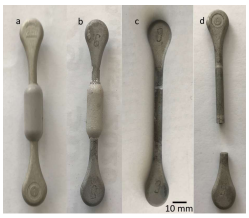


Absorption of Hydrogen by Ti at room Temperature
Release of H_2 at high T (1100 °C) under vacuum



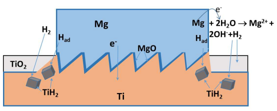
Garamus, V.M.; Limberg, W.; Serdechnova, M.; Mei, D.; Lamaka, S.V.; Ebel, T.; Willumeit-Römer, R. Metals 2021, 11, 527.

H_2 absorption mechanism and control of Mg degradation via PEO

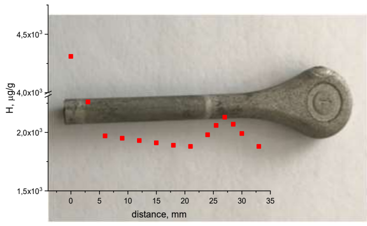


Dog-bone-shape tensile test samples of hybrid Ti64/Mg-0.6Ca after metal injection molding (MIM) production (**a**), sintering (**b**), corrosion (**c**) of Mg and tensile test (**d**).

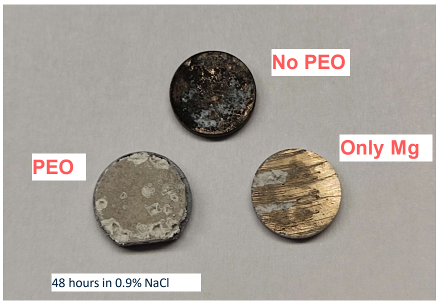
Concentration of absorbed H along the length of dog-bone sample after degradation of Mg alloy.

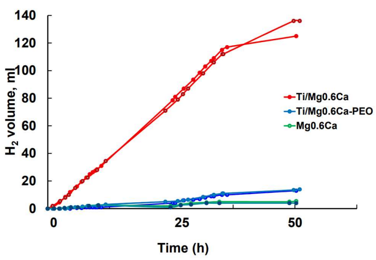


Possible scheme of loading of hydrogen (H_{ad} and H_2) into the titanium part



Humboldt fellowship of Dr. M. Fazel „Development of innovative approaches towards surface biofunctionalization of selectively biodegradable Mg-Ti hybrid implants„ from September 2022 (MOF/MBP)





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