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Carbon in titanium alloys – problems or benefits?

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Due to unique properties of titanium alloys, they are still considered to be one of the most promising group of materials. Because of the high production costs of titanium alloys, they are preferred material of choice mainly for application in aerospace and military industry. Wide spread applicability of titanium alloys to other applications such as automotive or medicine, requires reduction of total manufacturing cost. One of the basic strategies for reducing the production costs of titanium alloys is to replace expensive alloying elements with cheaper equivalents. Very popular cost-reduction approach is also reduce Al and replace it with O and N.

The presented work concerns the characteristics of microstructure and properties of titanium with higher carbon content. The obtained results can be summarized as follows: carbon, existing in interstitial solid solutions and non-stoichiometric titanium carbides, added to technically pure titanium and titanium alloys in the amount 0.2 wt% (exceeding the current content of 0.08 wt%, but not exceeding the maximum allowable content) results in improvement in their properties by significant increase in strength properties and hardness, increase in Young's modulus, creep, oxidation and abrasive wear resistance, heat treatability by providing the possibility of hardening in combined solution heat treatment and ageing processes and stability of structure at elevated temperature as well as reduction in a susceptibility to grain growth. At the same time, this does not cause the deterioration of ductility, hot formability and corrosion resistance. The negative consequences of the presence of 0.2 wt% of carbon in titanium alloys is deterioration of impact strength (impact energy) and cold formability.

Some presented results are based on the experience from earlier studies conducted in the present Department of Materials Technologies at Faculty of Materials Engineering of Silesian University of Technology, on the possibility of melting the classical titanium alloys and titanium aluminides in vacuum induction furnace with graphite crucibles.

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Structural and corrosion behavior characterization of bioresorbable Ca-Mg-Zn-Yb-B-Au alloys

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Bioresorbable alloys are usually metals and metalloids that degrade safely within the human body. Magnesium-basedalloys with zinc and calcium are the primary metal materials in this category. They are often used as bioresorbable stents. Moreover, Ca-Mg-Zn alloys with boron, ytterbium, and gold are a new family of bioresorbable materials that are applied as potential orthopedic implants.

The highest corrosion rate of the currently prepared Ca-based alloys limited them to use as medical implants. Corrosion activity may be controlled by the introduction of alloying elements such as boron and gold. Therefore, the objective of the investigation is to study the effect of addition of B and Au on glass-forming ability and the active behavior of Ca-Mg-Zn-Yb metallic glasses in Ringer's solution.

New resorbable Ca32Mg12Zn38Yb18-2xBxAux (x=1,2) alloys were designed and prepared in order to verify their use for medical applications as potential short-term implants. Their amorphous structure, which contains some crystalline phases, was determined by X-ray and neutron diffraction and electron microscopy methods. The biocorrosion behavior of the plates was tested by hydrogen evolution measurements, electrochemical polarization tests, and electrochemical impedance spectroscopy in Ringer's solution at 37 °C. The corrosion analysis was also supplemented by X-ray diffraction, photoelectron, and ICP-AES spectroscopy.

Corrosion resistance measurements revealed that the alloys manifest improved corrosion resistance. The corrosion current density for Ca32Mg12Zn38Yb18-2xBxAux (x=1, 2) alloys was 18.46 and 8.79 μA/cm^2, which is lower than for pure Mg (47.85 μA/cm^2) and Zn (33.96 μA/cm^2). A decreasing tendency for hydrogen to evolve as a function of time was noted. The evolution of hydrogen did not exceed 1 ml/cm^2 over 1 h and the average corrosion rate is calculated as 0.32 g/m^2 for Ca32Mg12Zn38Yb14B2Au2 alloy after 312 h. The corrosion mechanism of the alloys includes an anodic dissolution, a precipitation of hydroxides, the layer of the formation of the corrosion product, and corrosion propagation stage.

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