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BIOACTIVITY AND CORROSION BEHAVIOR OF MAGNESIUM ALLOYS TREATED BY PLASMA ELECTROLYTIC OXIDATION

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As a lightweight and nontoxic metal with mechanical properties similar to those of natural bones, magnesium based materials have attracted much interest in biomedical engineering. As the materials are both biocompatible and biodegradable, they can be used in many orthopedic and load-bearing applications. However, the poor corrosion resistance of magnesium-based biomedical implants in a physiological environment has hampered their use as substitutes for human hard tissues. Recently, plasma electrolytic oxidation (PEO) that is derived from anodic oxidation technology has been applied to treat valve-metals such as Al, Mg, Ti and their alloys. By utilizing micro-arc plasma discharges sustained at a high voltage in aqueous solutions, various oxide films can be formed on these metals to improve their surface properties such as wear and corrosion resistance as well as bioactivity. In this work, PEO treatments are conducted on magnesium alloys in different electrolytes and different voltage modes. The corrosion resistance is determined in simulated body fluids (SBF) based on the potentiodynamic polarization curves, and the surface bioactivity is investigated by monitoring the apatite inducing capability. The structure and chemistry of the plasma-formed surface oxide which exhibits a porous structure are evaluated. Our results show that the corrosion resistance and bioactivity of the PEO Mg alloys are much improved.

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A SELF-CONSISTENT COMPUTATIONAL MODEL FOR A THERMIONIC ENERGY CONVERTOR*

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High grade heat sources used to drive mechanical conversion systems suffer from losses of 30-40% due to friction and fluid losses, as well as venting as much as 40% of the energy as waste heat. System complexity and cost is also driven by conversion mechanisms. Direct conversion of part or all of the heat to electrical energy could be part of an overall efficiency improvement strategy. The direct conversion mechanism should not only be efficient, but also inexpensive, compact, and low maintenance. Potential applications range from high temperature small engine designs to nuclear power direct converters.

Thermionic energy converters (TECs) can meet many of these criteria. A TEC comprises a small vacuum gap (~10 microns) between a thermionic emitting electrode and a collector, sometimes with a fill gas to neutralize some of the space charge. TECs can operate at high temperatures approaching the adiabatic combustion temperature of most hydrocarbon fuels or the core temperature of a nuclear reactor, and hence have a high Carnot efficiency. They have no moving parts, and use electrons in a vacuum or low pressure gap as the working fluid, eliminating friction and working fluid losses and associated complicated parts and maintenance.

Current TEC performance is constrained by the space charge limited current within the gap. The transmitted current can be increased using neutralizing plasma, but the current required to ionize the background gas reduces the power output of the TEC by about 50%.

In this work, a one-dimensional model of a TEC using argon gas is developed. The model includes self consistent space charge effects, kinetic effects, impact ionization of the background gas, and an external circuit including the external load and impact on the electron transport in the gap via the surface charge. The model is implemented in the one dimensional particle-in-cell code, XPDP1 [1] and compared with theoretical predictions.

[1] J. P. Verboncoeur, M. V. Alves, V. Vahedi and C. K. Birdsall, J. Comput. Phys. 104, 321-328 (1993)

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