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Controlled copper release from Ti-Cu films: effect of reduced pressure during HiPIMS deposition

Vitezslav Stranak[1], Harm Wulff[1], Carmen Zietz[2], Steffen Drache[1], Martin Cada[3], Zdenek Hubicka[3], Rainer Bader[2], Rainer Hippler[1]

[1]University of Greifswald, Greifswald, Germany [2]University of Rostock, Rostock, Germany [3]Academy of Sciences of the Czech Republic, Prague, Czech Republic

stranv00@centrum.cz

The goal of our work is to develop a technique for deposition of Ti-Cu thin films with defined copper release to be used as coatings of bone-contacting parts of hip joint endoprostheses. The copper released from the film after the implantation provides an antibacterial effect which reduces the risk of post-operation infections. However, the copper release has to be controlled to achieve relevant effect against bacteria combined with enabled adhesion of osteoblastic cells on the surface.
For that purpose graded Ti-Cu films were prepared using the hybrid-dual-HiPIMS deposition technique. The unipolar hybrid-dual-HiPIMS system is based on a combination of dual-HiPIMS (f = 100 Hz, duty cycle 1%) with mid-frequency (MF) discharge operated at f = 94 kHz. A feature of this hybrid system is a pre-ionization enabling: (i) to reduce significantly the working pressure by one order of magnitude, (ii) to increase and control the energy flux towards the substrate, and (iii) to enhance ionization of metal species at lower pressure.
The main aim of this contribution is to find the correlation between plasma parameters, film properties and subsequently the copper release. Langmuir probe, retarding field analyzer (RFA), and calorimetric probe were employed to determine the ion and electron distribution functions and the total energy flux towards the substrate. Film properties as crystallography, density, film thickness, and chemical composition are evaluated by XRD, XR and XPS methods. The copper release is measured after the insertion into the cell cultivation liquid by the atomic absorption spectroscopy. Here, the copper release is influenced by the crystallographic structure linked to the energy flux towards the substrate during the deposition.
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HiPIMS
crystallography
copper release