The 10th International Congress of Societas Humboldtiana Polonorum

Longevity – a blessing or a curse? Medical, technological, cultural, socio-economic and legal aspects.

Ein langes Leben – Segen oder Fluch? Medizinische, technologische, kulturelle, sozio-ökonomische und rechtliche Aspekte.

Długowieczność – błogosławieństwo czy przekleństwo? Aspekty: medyczny, technologiczny, kulturowy, socjoekonomiczny i prawny.

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Thermomechanical Investigation of Gum Metal – a New Innovative Titanium Alloy for Biomedical Applications

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Bioengineering is a rapidly developing area of technology embracing: tissue engineering, diagnostic and special therapy equipment, prosthetics etc. The area is multidisciplinary and includes: mechatronics, biology, chemistry and materials science. In particular new materials need to meet specific requirements among many: biocompatibility, mechanical criteria and high reliability. Titanium alloys are well known for their excellent biological and mechanical performance when applied to biomedical devices. One of them called Gum Metal is a new β-type Ti alloy developed in Japan in the 21st century offering outstanding properties. It combines high elasticity and flexibility of rubber (Youngs's Modulus $E \approx 70$ *GPa*) with strength of metal (Ultimate Tensile Strength $UTS \approx 1100$ *MPa*), as well as biocompatibility of pure α-type Ti, making it a good candidate for biomedical applications. Gum Metal is fundamentally composed of Ti_3 (Ta, Nb, V)+(Zr, Hf, O). The alloy is fabricated by powder sintering technique and processed by cold rolling.

The presented research aims at Gum Metal thermomechanical characterization, since the temperature changes observed during the alloy deformation serve to describe precisely its elasto-plastic behavior and to learn more about still unknown deformation mechanisms. To this end, a specially designed experimental set-up combining a testing machine with an infrared measurement system was used. Since fatigue performance is critical for implants functionality, cyclic loading tests of Gum Metal were performed at various stain rates. A number of cycles till rupture was determined. Typical tension loadings were also realized. Strain-stress curves indicating non-linear elasticity of the alloy were plotted. The accompanying temperature changes were registered and the elasto-plastic regimes were determined. Thermograms, showing temperature distribution of the Gum Metal specimens were analyzed in order to identify localization, necking and rupture phenomena. The mechanical properties and temperature changes in both cyclic and classical loading tests till rupture were compared. The results showed good performance for biomedical applications. Corrosion resistance, wider fatigue analysis as well as surface treatments and osseointegration will be topics of interest for further investigation.