Effects of Laser Surface Processing on the Biocompatibility of a Potential Biomedical Alloy: High Entropy TiTaHfNbZr Alloy

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Abstract:
For load-bearing orthopedic applications, biomedical alloys which are advantageous in terms of mechanical properties are widely preferred, however biocompatibility and osseointegration of metallic alloys are still needed to be improved. For this purpose, novel biomedical alloys are being developed and various surface treatment methods are applied to these alloys. Among the new generation alloys, TiTaHfNbZr alloys; which belong to the class of high entropy alloys - an alloy class that has raised attention in recent years in terms of their mechanical properties- are biomedically promising as well, in terms of their elemental content and their potential elastic compatibility with the bone tissue. Among the surface modification methods applied to metal alloys, femtosecond surface treatment methods stand out as an effective method for biomedical applications as they enable formation of controllable patterns and homogeneous topography formation on the surface, while not causing problems su
ch as melting and phase transformation with their short-term interaction with the material. However, in the literature there arenâ€™t any studies focusing on the utility of high entropy alloys for biomedical applications, through modifying their surface with laser processing methods. With this motivation, the current study focuses on obtaining surfaces with different topographic properties by processing the TiTaHfNbZr alloy surfaces with a femtosecond laser and to thoroughly investigate the effect of the obtained surfaces on biocompatibility. Within the scope of the experimental methods, surface of the TiTaHfNbZr alloys were modified by femtosecond laser processing to create surfaces with different topographic properties, surface energy, contact angle and wettability by forming patterns in various shapes and repetition frequencies, and the properties of these surfaces were characterized. Following these processes, biocompatibility of the created surfaces were comprehensively investi
gated via ex situ and in vitro biocompatibility tests, in order to determine the surface pattern with the most promising biocompatibility response.