Enhancing Biocompatibility of Stainless Steel Surfaces Through Laser Functionalization in an Argon Atmosphere

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Metallic biomaterials such as stainless steel, are widely used in biomedical applications because of their excellent mechanical properties and low-cost. At the same time, they enable different surface functionalization processes that modify surface morphology, surface chemistry and surface wettability. These physiochemical properties of the surface regulate biological interaction at the material-cell interface. Therefore, the modification and functionalization of the surface, which comes into direct contact with biological systems, play an important role in biomaterial design.

Within this context, laser surface engineering can be used for controlled surface transformation on micro- and nanoscale, thereby significantly change its properties and transform its functionality without affecting the properties of the bulk material. These modifications, occurring in a thin surface layer, depend on laser parameters (orientation of light, pulse fluence, pulse duration, polarization and wavelength) and processing environment.

The processing environment has a significant influence on the surface morphology and chemistry of the material. When laser surface processing of stainless steel is carried out in an argon environment, it effectively reduces the formation of toxic chromium oxides, thereby enhancing biocompatibility in terms of adhesion behaviour, cellular viability, cell shape, and cell morphology as compared to samples processed in ambient conditions. These findings underscore the potential of laser surface functionalization in optimizing cellular responses and improving biocompatibility properties of metallic biomaterials.

Keywords: laser processing, surface functionalization, stainless steel, biocompatibility