coatings

Supplementary Material: Fibre Laser Treatment of Beta TNZT Titanium Alloys for Load-Bearing Implant Applications: Effects of Surface Physical and Chemical Features on Mesenchymal Stem Cell Response and *Staphylococcus aureus* Bacterial Attachment

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Calculations related to laser energy and intensity for the fibre laser surface treatment:

The focal spot diameter ($d_{e^{-2}}$) can be obtained by Equation (1):

$$d_{e^{-2}} = \frac{4\lambda f}{\pi D_{e^{-2}}} \times M^2, \tag{1}$$

where $d_{e^{-2}}$ is focal spot diameter, λ is the wavelength of the laser beam, f is the focal length of lens, $D_{e^{-2}}$ is the diameter of the beam before the lens and M^2 is the beam mode parameter of the fibre laser.

Given that λ, f, $D_{e^{-2}}$, and M^2 are 1.064 µm, 125 mm, 5 mm, and 1.2 respectively.

By substituting these values into Equation (1), the focal spot diameter ($d_{e^{-2}}$) is 41 µm.

The laser spot diameter at the stand-off distance of 1.5 mm can be obtained using simple trigonometry. After calculations, it is 100 µm.

The laser intensity (W/cm^2) can be obtained by Equation (2):

$$Laser\ Intensity\ (W/cm^2) = \frac{Laser\ Power\ (W)}{Spot\ Area\ (cm^2)}, \tag{2}$$

The laser spot area at the stand-off distance of 1.5 mm is 7.9×10^{-3} mm^2, and the laser power is 30 W.

By substituting these values into Equation (2), the laser intensity is 3.8×10^5 W/cm^2.

The laser energy (J) can be calculated by Equation (3):

$$Laser\ Power\ (W) = \frac{Laser\ Energy\ (J)}{Processing\ Time\ (s)}, \tag{3}$$

The processing time (s) for each laser track can be calculated by Equation (4):

$$Processing\ Time\ (s) = \frac{Scanning\ Distance\ (mm)}{Scanning\ Speed\ (\frac{mm}{s})}, \tag{4}$$

Given that the scanning speed are 100 and 200 mm/s, scanning distance (or length of each laser track) is 6 mm, and the laser power is 30 W.

By substituting the values into Equations (3) and (4), the laser energy at the two speeds are 1.8 and 0.9 J respectively.