Blood Coagulation on Electron Beam Melted Implant Surfaces, Implications for Bone Ingrowth

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INRTODUCTION

Electron beam melting (EBM) has great potential in manufacture of various implant geometries for bone replacement. The surfaces have an intrinsic roughness originating from melted metal powder grains (see figure 1). The EBM-machine process parameter settings affect the surface properties to some extent. According to Frosch et. al. rougher surfaces promote bone ingrowth[1]. In addition the thrombogenic behaviour of implants is believed to be important for osseointegration. [3]

This work is an investigation of how the EBM process parameters affect the surface's thrombogenic properties and relate it to bone ingrowth.

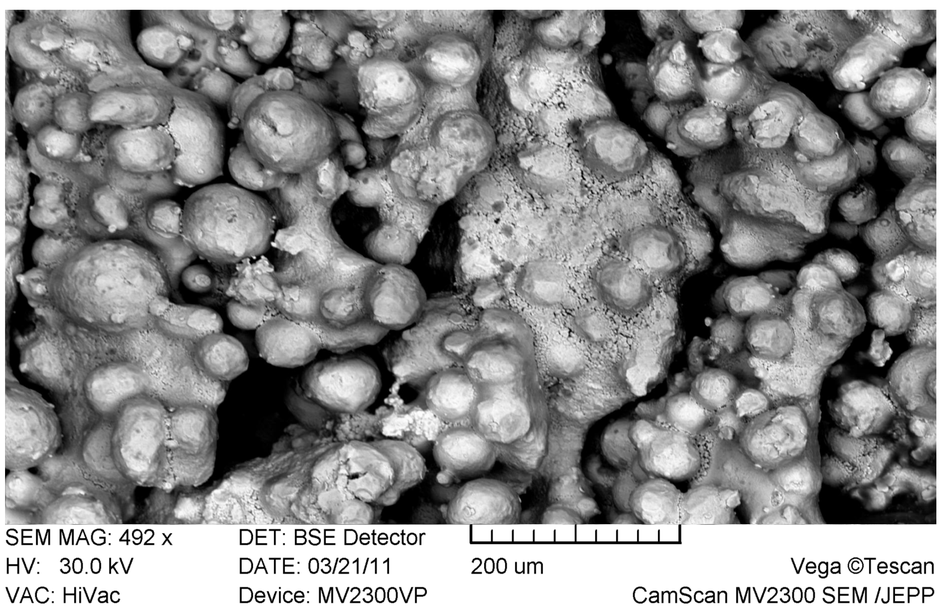


Figure 1: *Scanning electron microscope image of a flat EBM intrinsically rough surface.*

METHODS

The manufacture of the test specimens was carried out with Arcam A2 EBM® equipment. Material was a cobalt-chromium based alloy. Process parameters were changed in the software EBM control[2] and three groups of eight coin like specimens were manufactured with different parameter setting. The specimens were then tested with fresh whole blood from two individuals in a modified version of the blood chamber model[3] (see Figure 2). Surface roughness was also characterised using a stylus profiler Dektak® 6M.

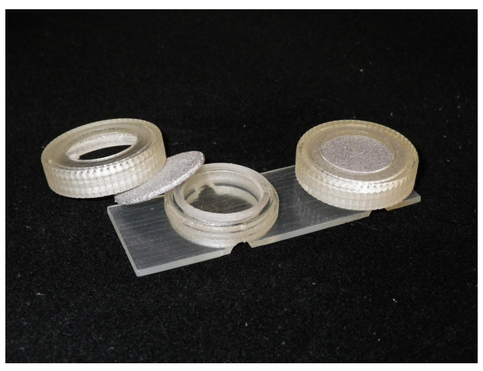
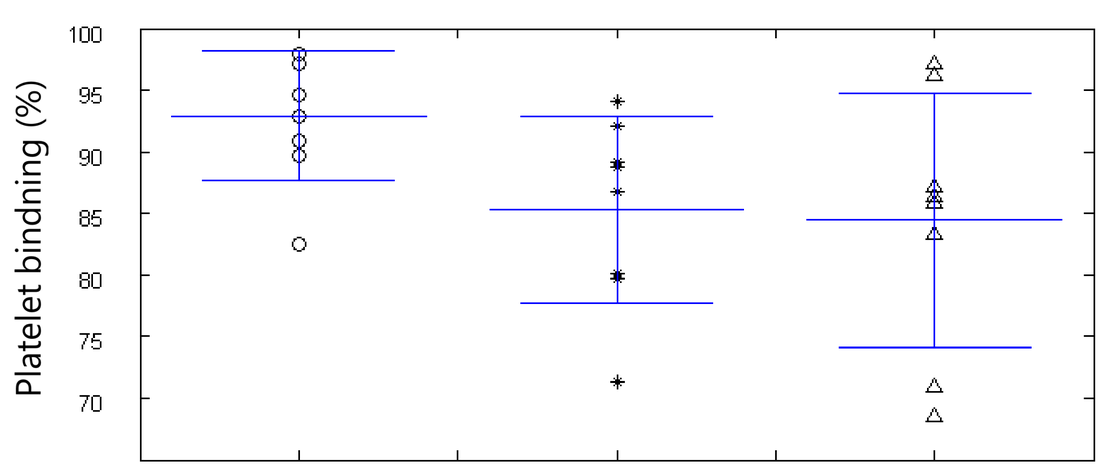


Figure 2: *Specimen and chambers used in the Blood Chamber model.*

RESULTS

Thrhombogenicity is presented visually in Figure 3.



Mean R_a	35.0µm	28.5µm	28.2µm
Std R_a	3.24µm	2.14µm	1.7µm

Figure 3: Shows *the percentage of platelets bonded to the surfaces versus* mean *values and standard deviation of average surface roughness (R_a).*

CONCLUSION

The surface properties of the EBM manufactured specimens are affected by the process parameters. The results in Figure 3 corresponds well with previous results that rougher surfaces promotes bone ingrowth[1]. The measured thrombogenicity dependence of surface properties (Ra) clearly indicates that the EBM process parameter settings could affect the final bone response in a positive manner.

FURTHER WORK

When flat EBM intrinsically rough surfaces are sufficiently investigated a further research on 3D mesh and net structures (see Figure 5) will be done. Then the lattice size of the mesh will be the object of the research. A net or mesh structure have less strength but better flexibility than the solid counter parts witch could be more suitable for replacement of human bone. Experiments will be carried out *in vivo* as well as *in vitro*.

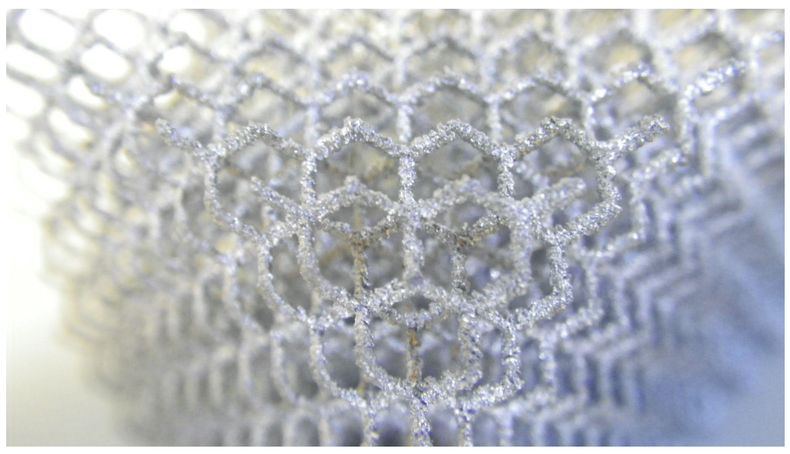


Figure 5: *Photograph of a 3D mesh structure.*

REFERENSES 1.Frosch, K.H. and K.M. Stürmer, *Metallic biomaterials in skeletal repair.* European Journal of Trauma, 2006. **32**(2): p. 149-159. 2.Arcam, A.; Available from: www.arcam.com. 3.Thor, A., et al., *The role of whole blood in thrombin generation in contact with various titanium surfaces.* Biomaterials, 2007. **28**(6): p. 966-974