

Direct Observation of the Formation of Collagen at Dental Implant Surfaces

Lucille A. Giannuzzi¹, Daniel Phifer¹, Nicholas J. Giannuzzi², Mario J. Capuano³, Richard P. Gursky¹, and Lee Pullan¹

¹FEI Company, 5350 NE Dawson Creek Drive, Hillsboro, OR 97124

²10 Hunter Ave., Miller Place, NY 11764

³Long Island Oral and Maxillofacial Surgery, 260 Middle Country Road, Selden, NY 11784

Statement of Purpose: Focused Ion Beam (FIB), scanning electron microscopy (SEM), and (scanning) transmission electron microscopy ((S)TEM) methods were used for specimen preparation and analysis of failed dental implant. Previous work showed evidence of bone formation and interdiffusion at the dental implant coating interface using 2D and 3D microscopy techniques [1]. In this report, we present evidence of collagen formation at the surface of the implant coating using direct TEM and STEM imaging techniques from FIB prepared cross-sectioned specimens.

Methods: A Nobel Biocare TiUnite dental implant was surgically removed from a human patient due to implant mobility upon stage 2 uncovering of the implant. The implant was mounted on an Al sample stub using carbon paint and was directly analyzed using an FEI Nova NanoLab 600 DualBeam (FIB + SEM) instrument. The DualBeam instrument was used to prepare a TEM cross-sectional specimen encompassing the bone/implant coating/implant substrate interfaces using the FIB-based techniques [1]. (S)TEM analysis was performed on an FEI Tecnai F20 operating at 200 keV.

Results: Figure 1 shows a cross-section high angle annular dark field (HAADF) STEM image of the implant coating surface. The HAADF STEM image yields atomic number (Z) contrast information and therefore, the coating appears bright while the collagen region shows a mottled gray contrast. The mottling is due to diffraction contrast of the collagen which is evident in the higher magnification bright field (BF) TEM image of figure 2.

Conclusions: FIB-based specimen preparation techniques successfully provided for cross-sectioned (S)TEM specimens of dental implant interfaces. STEM and TEM analysis yields direct evidence of collagen formation at the coating of the dental implant.

References:

[1] L.A. Giannuzzi et al., J Oral Maxillofac Surg (2007) 737.

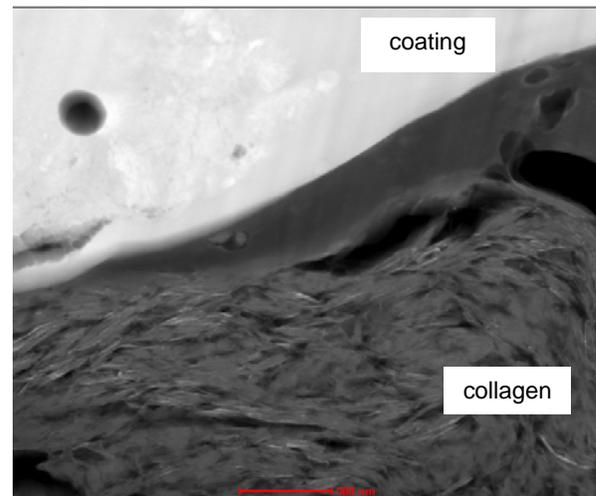


Figure 1. Cross-section HAADF STEM image of collagen formation on the TiUnite dental implant coating.

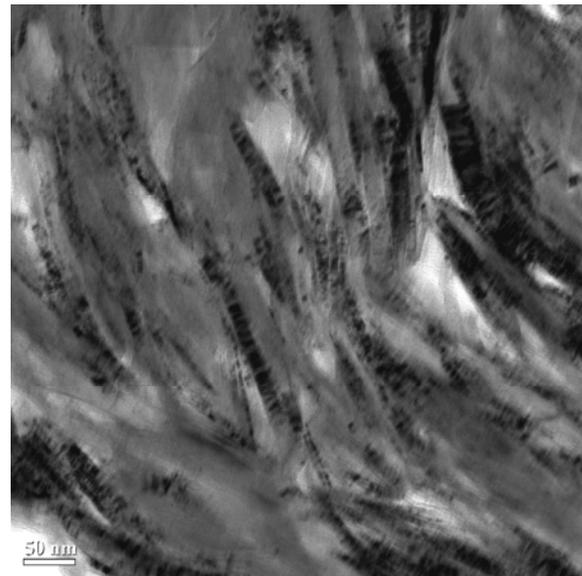


Figure 2. BF TEM image of collagen observed in fig. 1.