The combination of focused ion and electron beams within the vacuum chamber of the Tescan LYRA3 XM instrument at the Oxford Multi-Beam Laboratory for Engineering Microscopy (MBLEM) provides a set of versatile tools for structural and mechanical characterisation of natural and engineered materials. In the present study we report the use of SEM for imaging, and FIB for ion beam milling and TEM lamella preparation of samples of human dentine and enamel, the two principal tissues used by nature to build teeth. We also pay particular attention to the dentine-enamel junction, the DEJ, a functionally and structurally graded interface that accommodates significant change in the degree of mineralisation (nearly two-fold), stiffness (nearly five-fold) and hardness (two-fold). We report using the combination of synchrotron X-ray diffraction with FIB ring-core milling to determine the variation of the lattice parameter of the mineral content, the nanocrystalline hydroxyapatite (HAp) particles. The use of FIB-DIC allows the separation of lattice parameter variation into chemical changes and mechanical effects (residual elastic strains) in the vicinity of the DEJ. In addition, the analysis of TEM lamella extracted from the sample made it possible to visualise the fractures observed in the dental tissues, and to explain the toughening mechanisms that operate at the nano-scale in these materials. The combination of synchrotron X-ray diffraction with FIB ring-core milling was also used to determine the variation of the hydroxyapatite (HAp) lattice parameter and elastic strains in the vicinity of the DEJ.

Acknowledgement: We acknowledge the support of colleagues at Tescan in UK and CZ: Ray Codd, Zora Strelcova, Jiri Dluhos and many others.