The Road Nano Scale DVC metrology with In Situ Computed Tomography

Alex Arzoumanidis*[1], Brian Bay[2], and André Phillion[3]

[1]Psylotech, Inc. – United States

[2]Oregon State University; School of Mechanical, Industrial, and Manufacturing Engineering – United States

[3]McMaster University [Hamilton, Ontario] – Canada

Abstract

An in situ universal mechanical testing system is presented with a rotating load train. Rotating the specimen offers a number of advantages for computed tomography. In conical beam microCT, the source can be placed close to the sample, maximizing appraisal resolution compared to systems with polymer to be support structures. Also compared to tubular alternatives, samples are simpler to mount and no X-rays are attenuated. For nanoCT, placing the source and detector closer to the sample reduces scan time.
Despite the advantages, rotating the load train within the frame introduces substantial challenges. For example, two rotation axes increase alignment complications. A four degree of freedom alignment fixture is shown to be critical for micron scale tomography. Additionally, a second rotating axis exacerbates bearing runout errors in the reconstruction. The ultimate goal is micron scale resolution, which is finer than the specifications of high precision bearings.

A software solution is proposed for the mechanical runout problem. Consider that digital image correlation has been shown to achieve sub pixel displacement field resolution as small as 1/100th of a pixel. Such careful DIC requires imaging system calibrations. Analogous procedures can be applied to DVC. Spherical fiducial markers are first bonded to the top and bottom of the sample's gauge section with a low modulus adhesive. The markers are tracked in all of the radiographs of the tomography scan. The software solution then leverages DIC methods to measure runout from the marker positions, comparing them to ideal. Finite element algorithms distort and stretch the radiographs before reconstruction, correcting for errors. The result is a plausible path to achieve sub-micron metrology in 3D space.

*Speaker