IOWA STATE UNIVERSITY
Center for Nondestructive Evaluation

CNDE Webinar Presentation
January 9, 2025 - 10:00 a.m. CST

This webinar will be recorded and made available on the CNDE website

Using Computed Tomography to Study the Density, Packing, and Crushing of Materials

Presented by:

Dr. Michelle Espy, Scientist
Los Alamos National Laboratory (LANL)
Los Alamos, NM, US

Abstract:

Computed Tomography (CT) with x-rays is a ubiquitous tool for non-destructive evaluation of the internal structure of materials by measuring the attenuation of x-rays through the item being examined. This attenuation follows the Beer-Lambert law and thus depends on both the density and attenuation coefficient of the materials the x-rays pass through. The results of a CT scan are usually visualized as a series of 2D grey-scale images or "slices" that provide information on the internal attenuation structure as a function of position. It is tempting to ascribe quantitative density information to the grey-scale value of these images; however, this should be done with caution. The attenuation coefficient is a function of energy, and the x-ray sources in most conventional CT scanners have an energy spectrum. Thus, the relationship is complicated by this, and also by the presence of scatter in the images (a factor almost never considered). Nevertheless, there are methods to try and correlate the grey-scale value in a CT scan to a density.

CT also provides insight into properties of material behavior such as how granular materials crush or pack to fill space. Using sucrose and salt crystals we performed CT scans after discrete crushing increments to visualize the evolution of the volume-weighted particle size distribution (PSD). As expected, the PSD developed toward a fractal distribution. Using plastic spheres, we also investigated the use of CT to evaluate the number of contact points per sphere (coordination number) during packing, and how this depends on the ratio of container to sphere diameter.

This talk presents the results on various uses of conventional commercial micro-CT systems to extract density to better than 1%, as well as what we have found to be limitations and challenges to using CT to measure density. We also discuss the results of experiments in crushing and packing. The utility of CT as a diagnostic for both crushing and packing depends on CT data quality and the ability to effectively post-process, and in particular segment, for the desired information.

Speaker:

Dr. Michelle Espy is a scientist at Los Alamos National Laboratory (LANL). She received her BS in physics from the University of California, Riverside in 1991. After receiving her PhD in nuclear physics from the University of Minnesota in 1996, Dr. Espy joined LANL as a Director's Fellow post-doc. In 1998, she became a staff scientist in Physics Division. In 2015 she moved to the Engineering Technology and Design Division, Non-Destructive Testing and Evaluation group. Her specific areas of interests include novel nuclear magnetic resonance (NMR) techniques including ultra-low field NMR and nuclear quadrupole resonance (NQR) for detection of illicit materials, and imaging with a variety of radiographic probes. For the past nine years, she has focused her efforts on methods of imaging based on x-ray, neutron, and proton radiography and computed tomography (CT) for characterization of materials. She is especially interested in using micro-CT to study how materials press, pack, and crush. She has also used high energy CT on a variety of "unconventional" specimens including large dinosaur fossils. Dr. Espy also has significant experience in spectral characterization of continuous and dynamic x-ray sources using Compton Spectrometers. She has been PI on numerous projects, over 90 peer-reviewed publications, 11 patents, and over 2600 citations. In 2014, she was made a Fellow of the American Physical Society in the Division of Nuclear Physics. Her proudest professional accomplishment is mentoring dozens of students and post-docs, for which she has been recognized with both DOE and LANL Outstanding Mentor awards.

To view live:

Please click this URL to start or join. Participant ID: Shown after joining the meeting
https://iastate.zoom.us/j/93218616476?pwd=y8u6oRTZlUrHtJLKC6wbE640lV5hzi.1
International numbers available: https://iastate.zoom.us/u/acu403e9U7
A copy of the recorded webinar will be posted at: https://www.cnde.iastate.edu/