Measuring Sonics, Part 2

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Ultrasonics and megasonics have become mainstays for the removal of contaminants from critical product. As we discussed last month, ultrasonics metrics is in its infancy, with the most widely used test for ultrasonic functionality still observation of the visual erosion of aluminum foil. (The test, which is qualitative, is dependent on technique and foil thickness. It is important to choose standard-weight foil; heavy-duty foil is unlikely to erode to form the classic orange-peel pattern.)

Another technique, which provides an indicator of ultrasonic cavitation and frequency, involves immersing a tube filled with a suspension of fine particles in liquid. If the tube is placed in an ultrasonic tank with active cavitation, the slurry will partition into bands; the distance between the bands is inversely proportional to the frequency.

Quantitative ultrasonic and megasonic (u/m) probes have been proposed and evaluated with varying success. In the past, widespread adoption of metrics has been hampered by instability or unexplained variability of readings, lack of standardization in measuring units, and an unclear understanding or documentation of the relevance of measurement to process performance. Two techniques that show promise to for characterizing u/m sonics are emerging: a u/m meter which provides a general measure of sound related energy, and a second, which we will discuss next month, based on sonoluminescence, a specific phenomenon associated with the collapsing cavitation bubble.

The quantitative metric probe, which provides a general indication of energy level, is being adopted for process control. While its principle of operation is proprietary, some overall characteristics can be noted. The stainless steel or quartz probe may be thought of as a sort of super hydrophone in that it detects both the imploding solution bubbles and the sound waves produced by the transducer.

In addition to being quantifiable, the technique has the advantage over aluminum foil erosion in that it can be used for frequencies ranging from ultrasonic to megasonics. The stable signal has allowed it to be adopted for general quality control/process monitoring. The meter provides an indication of how u/m energy varies within a given tank, both spatially and temporally.

The meter has a range of potential uses, including monitoring lysis of cells and echolocation of dolphins. Currently, its main applications are mapping relative energy levels in the u/m tank and monitoring tank life/tank failure. In one adaptation for use in wafer fabrication, the probe detector has been configured to the shape of a wafer, which can then be fixtured along with the product: this allows product performance in a given system. Removal of particles, for example, can then be profiled and related to energy level.

While the technique allows quantifiable monitoring of tank performance, one study indicated that the meter did not correlate with the classic aluminum foil corrosion test, where corrosion was measured gravimetrically.[1] However, the probe appears to be useful for monitoring system performance; so the group decided to use both the energy meter and aluminum foil approaches.

There are additional related techniques on the horizon. The current metric probe does not allow comparison of different energy frequencies. A second generation version will allow the user to measure both acoustic energy (the amplitude of the ultrasound) and cavitation energy.

We have described a general technique to quantify u/m energy. Next month, we will discuss a u/m metrics probe based on sonoluminescence, a new technique that shows promise of further refining our understanding of system performance.

References:

1 J. M. Kolyer, A.A. Passchier, and L. Lau, “New Wrinkles in Evaluating Ultrasonic Tanks,” *Precision Cleaning magazine,* May/June, 2000.2 Y. Wu, C. Franklin, M. Bran, and B. Fraser, “Acoustic Property Characterization of a Single Wafer Megasonic Cleaner,” Presentation and Proceedings, Electrochemical Society, Honolulu, HI, October, 1999