APPLICATION NOTE

Micro-Compression of Microcapsules and Nanoparticles

Quantitative Analysis of Mechanical Rupture Mechanisms

The use of microcapsules and nanoparticles has become common in developing and improving numerous new and existing applications today. In applications where mechanical properties of small-scale particles must be well-understood, testing techniques designed for analysis of bulk materials do not provide sufficient capability to fully characterize nanoparticles or microcapsules. The ability to quantitatively characterize mechanical integrity of such small particles is essential to application development and is easily enabled by Hysitron instrumentation.

In addition to providing industry-leading force and displacement sensitivity, the Hysitron **TI 950 TriboIndenter**® with its dual-head capability* provides the force and displacement range to test small particles of varying sizes from micron-sized microcapsules down to smaller scale nanoparticles or powders. In addition, the standard color video microscope optics allows users to define precise test locations (on individual particles), easily measure particle diameters, and qualitatively inspect particles before and after testing.

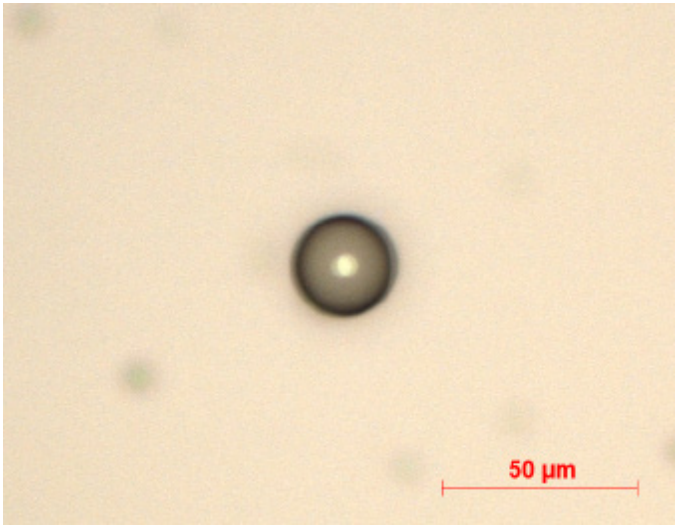

Figure 1. 20× optical microscope image of a liquid-filled microcapsule prior to micro-compression test. Microcapsule diameter can be quickly measured using **TI 950 TriboIndenter** color video microscope optics.

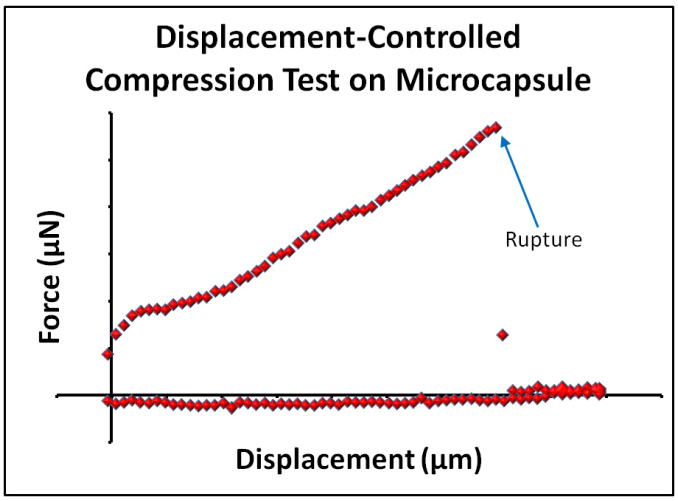

Figure 2. Representative force-displacement curve exhibiting a rupture event from a displacement-controlled micro-compression test on a liquid-filled microcapsule. Rupture load and displacement to rupture correspond to denoted rupture point.

* = Hysitron's standard 10 mN transducer + **Multi-Range Nanoprobe**™ or **3D OmniProbe**™

Example Study: Microcapsules

Microencapsulation involves coating of a liquid or solid material with the purpose to enable controlled release of the encapsulated material, a technique that can provide or enhance properties in a myriad of applications.

In microcapsule applications where mechanical rupture is the controlled release mechanism, precise measurements of

quantitative microcapsule rupture forces or displacements to rupture are required for proper improvement and complete documentation of the application being developed.

Figure 1 shows an optical micrograph of a typical liquid-filled microcapsule used in an application where mechanical rupture is the controlled release mechanism.

Figure 2 shows a plot of force versus displacement from a representative micro-compression test on a liquid-filled microcapsule. The test was performed closed loop in displacement control to allow clear identification of the rupture force and displacement in the resultant data; a test performed in load control with a time-linear increasing load would show a more continuous curve as an increasing load is attempted to be maintained. Probes used for such tests include flat-punch and large radius ball probes.

Figure 3 shows rupture data from a representative study on two different microcapsule types. Comparative analysis of the rupture loads or displacements for the two microcapsule types clearly reveals a higher rupture strength for Sample B. Such analysis provides clear, quantitative mechanical characterization of a sample and provides evidence for optimization of process development.

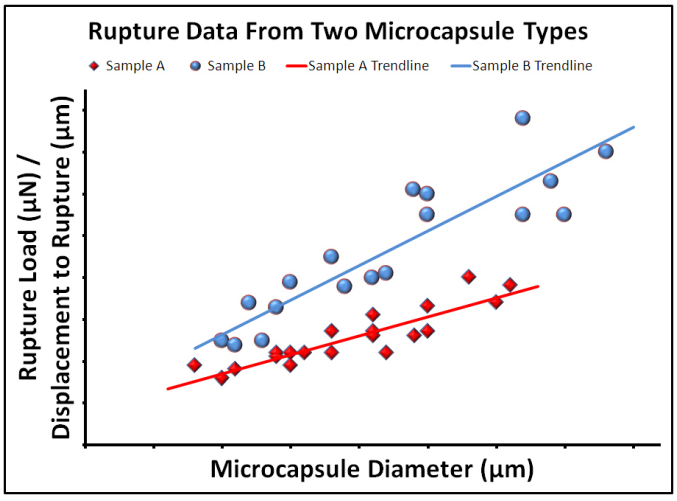

Figure 3. Rupture data from representative study consisting of 20 micro-compression tests on two different microcapsule types. Microcapsule Sample B clearly shows a higher rupture strength.

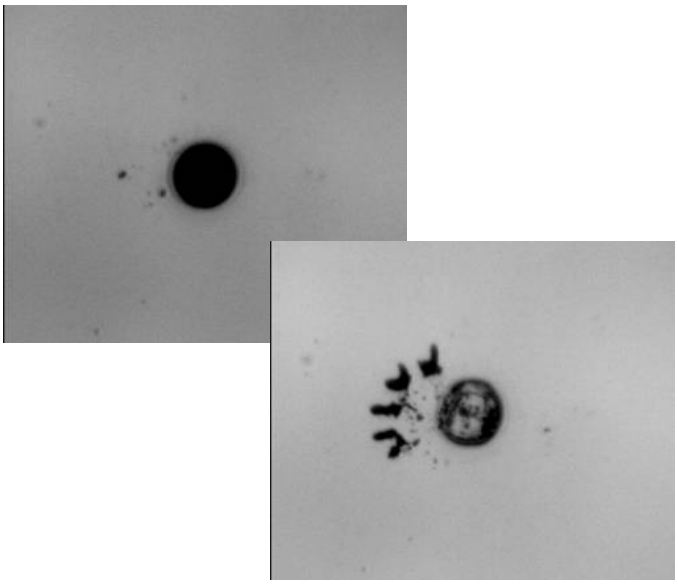

Figure 4. 20× optical microscope images of a liquid-filled microcapsule before and after micro-compression testing.

Figure 4 shows video microscope images of a liquid-filled microcapsule before and after rupture induced by a micro-compression test.

Conclusion

Micro-compression testing using Hysitron instrumentation enables quantitative mechanical analysis for development and verification of applications involving small-scale microcapsules and nanoparticles. Instruments used for traditional bulk mechanical analysis do not provide the sensitivity or the ability to precisely define test locations necessary for such small-scale applications.

Applications

- Carbonless paper (microcapsules)
- Textiles (microcapsules, nanoparticles)
- Controlled drug, scent, or flavor release (microcapsules)
- Nanoparticle composites
- Powders
- "Scratch and sniff" applications (microcapsules)

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