PROCESS COMPENSATED RESONANT TESTING

FAQs – RUSpec – F5

Quasar RUSpec FAQ

1. How does RUSpec determine elastic constants?

Ans - The RUSpec (Resonant Ultrasound Spectrometer) measures the resonant frequencies of sample materials of known dimensions, shape, and density. These measured resonances are compared with calculations of the modal frequencies based on an initial "guess" by the operator of the elastic constants. Typically, the guess is an educated one and is close enough to the actual value(s) so that the calculation algorithm provides a solution.

The solution is derived by using a Levenberg-Marquardt scheme to minimize the difference between the measured and calculated resonant frequencies as the estimated elastic constants are iteratively changed. When a best fit between the measured and calculated resonant frequencies is achieved, the elastic constants have been calculated. Accuracy is greatly influenced by how well the sample (a rectangular parallelepiped or a right cylinder) is fabricated and whether or not the sample is uniform and without flaws.

2. What advantages does RUSpec provide that conventional speed of sound, strain gauge measurements, or other methods do not?

Ans - RU Spec takes advantage of the ability to measure high frequency resonances with extraordinary accuracy over a wide temperature range to allow measurements of a wide size range of samples, including the very small (single crystals of a few mm in size), to accuracies previously unattained. These accuracies can be greater than 0.1%. Additionally, for those people interested in measuring elastic constants as a function of temperature, RU Spec can make measurements very rapidly as temperature changes from 3 degrees K to over 1850 degrees K.

Depending on accuracy requirements, each measurement can take from a few seconds to a few minutes without adjusting or touching the sample unless one needs to change from a cryogenic to a heating sample fixture.

3. Does Quasar provide the cryogenic and high temperature test fixtures?

Ans - Quasar provides a room temperature fixture (10 degrees C to 50 degrees C). On request, we will provide suggested designs for cryogenic fixtures available on request.

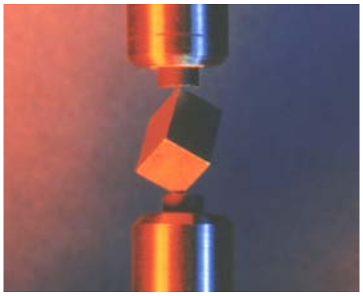
High temperature fixtures are typically designed and built by the user to satisfy their specific requirements. Quasar manufactures transducers with extra long tips for use in these high temperature applications.

4. Why does the sample have to be a rectangular parallelepiped (RP) or right cylinders?

Ans - When this technique was first perfected, desktop computers were relatively slow such that the fastest computational software was needed to make this method practical. The RP geometry was most appropriate in order to minimize calculation time. The next fastest shape calculation (cylinder) ran 4 to 8 times slower, depending on the particular computer and the parameters chosen. Since that time, however, computing speeds have increased dramatically. Quasar now provides a "Cylinder" version of the computational software, also. Other geometries are possible, however an additional concern is that other geometries require special programming to model and validate, and measurements can be very difficult. Quasar does not plan on including any other geometries in the future.

5. How do you mount a cylinder?

Ans – A cylinder is mounted edge-to-edge similar to the way a parallelepiped is mounted corner-to-corner (see the picture, below). Do NOT mount either the parallelepiped or the cylinder such that the flat tipped transducers are touching a sample face. The mounting must be at a single point on each end.



6. Can large samples be tested?

Ans – Yes. Samples as large as about 10 cm on a side have been tested with exceptionally good results. This requires a universal nest that uses three transducers (one drive and two receive) to hold the sample.

7. What are the requirements for accuracy and precision in sample preparation?

Ans – The sample, either cylinder or parallelepiped, must have opposing faces parallel to within better than 0.05%. The right angles made between any face and its perpendicular axis must be to within about 0.05 degrees or better. The surface smoothness must be better than 0.01% of the shortest dimension. For example, a fine, milled or turned finish on a metal sample is adequate for a sample that is 2.5 cm in its smallest dimension. If the highest accuracies are to be achieved, then finer surface finishes are required and better parallelism and more accurate right angles must be obtained. No corners or edges may be broken (rounded).

8. Which elastic constants are calculated, and how are they calculated?

Ans - The elastic constants measured (dynamic compared to static) are: Young's Modulus, Shear Modulus, Bulk Modulus, Poisson's Ratio, and Longitudinal and Shear Sound Velocities. These properties are calculated from the elastic constants. For example, the Shear Modulus for isotropic materials is equal to C44. Other properties are algebraically calculated and the bulk modulus derives from the model itself.