FAQ01-02 What is Z Factor?
How do I determine Z-Factor?

Z-Factor is a ratio of the acoustic impedances of two materials. It is used to match the acoustic impedance of the deposited material (Z_m) to that of the base quartz sensor material (Z_q=8.83):

$$\text{Z-Factor} = Z_q / Z_m$$

For example, the acoustic impedance of gold is Z=23.18, so:

$$\text{Gold Z-Factor} = 8.83 / 23.18 = 0.381$$

Calculation of Z-Factor

Z Factor can be calculated using the Shear Modulus of quartz (U_q) and the deposited material (U_m):

$$Z := ((D_q * U_q)/(D_m * U_m))^{1/2} \qquad \text{where } U_q \sim 32\text{Gpa}$$

Empirical Determination of Z-Factor

Unfortunately, Z Factor and Shear Modulus are not readily available for many materials. In this case, the Z-Factor can also be determined empirically using the following method:

1. Deposit material until Crystal Life is near 50%, or near the end of life, whichever is sooner.
2. Place a new substrate adjacent to the used quartz sensor.
3. Set QCM Density to the calibrated value; Tooling to 100%.
4. Zero thickness.
5. Deposit approximately 1000 to 5000 Å of material on the substrate.
6. Use a profilometer or iterferometer to measure the actual substrate film thickness.
7. Adjust the Z Factor of the instrument until the correct thickness reading is shown.

Another alternative is to change crystals frequently and ignore the error. The graph below shows the % Error in Rate/Thickness from using the wrong Z Factor. For a crystal with 90% life, the error is negligible for even large errors in the programmed versus actual Z Factor.