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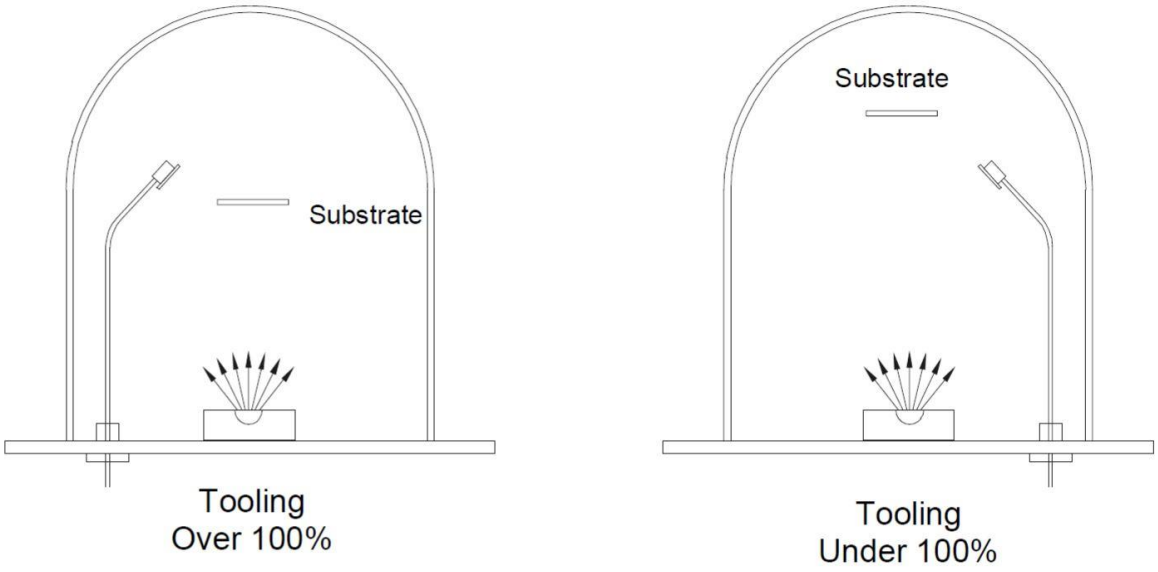
**Sensor Tooling:** Adjusts for sensor measured deposition rates that differ from the substrate deposition rate. A higher tooling value yields higher rates. A lower tooling value yields lower rates.




Furthermore, the relationship between the sensor and the substrate in relation to the source is geometric.

Source to sensor = x

Source to substrate = y

$X^2 / y^2$ = rough* tooling number

If x = 20cm and y = 30cm:

400 / 900 = .44 or 44% tooling

*There are many factors that can affect the precise relationship between the tooling number and the actual rate of deposition – including:

- The density of the material. Most common materials have known densities but many organics used in optoelectronics do not. So, a density of '1' is used and the tooling number can be used to account for the unknown density. This can only be done by comparing empirical film thickness with reported rates/thicknesses of deposition to further refine the tooling number accordingly.
- The shape of the evaporation plume. Aside from the relationship of distance between the sensor and substrate, the relative angles can also be a factor. Evaporation is thought to be 'line of sight' – like the sun, radiating energy in all directions evenly. While this simple model is accurate enough for many applications, it should be understood that the choice of source (dimple boat, crucible, baffle source, etc.) can have a effect on the disbursement of molecules from the source. To account for this the solution is also empirical measurements compared with reported thicknesses. Remember, if you change source type, you should check your tooling number.
- Rotation of the substrates during deposition. A rotating substrate platter will cause the deposition rate to wax and wane unless the deposition source is on axis with the center of rotation. Again, comparing the empirical thickness of test samples with the reported thickness is the best way to refine the tooling number.
- Deposition rate itself can also cause differences in actual thicknesses of a film. As an example a slow deposition of a large organic molecule will have a tendency to align with the substrate whereas a faster deposition rate can cause the film to be more random and therefore less dense. So, the deposition with the faster rate could be thicker yet have the same reported thickness on the sensor as a slower deposition of the same reported thickness.

For best results, it is important that the technician be consistent and thoughtful. When refilling or replacing boats, it is important that the boat is replaced in the precise location as it was removed. Nothing should block the line of sight from the source to the substrate and from the source to the sensor. Do not make the assumption that a similar material will have the same tooling. Every material should be individually tooled and also checked for its particular application to achieve the most precise results.