

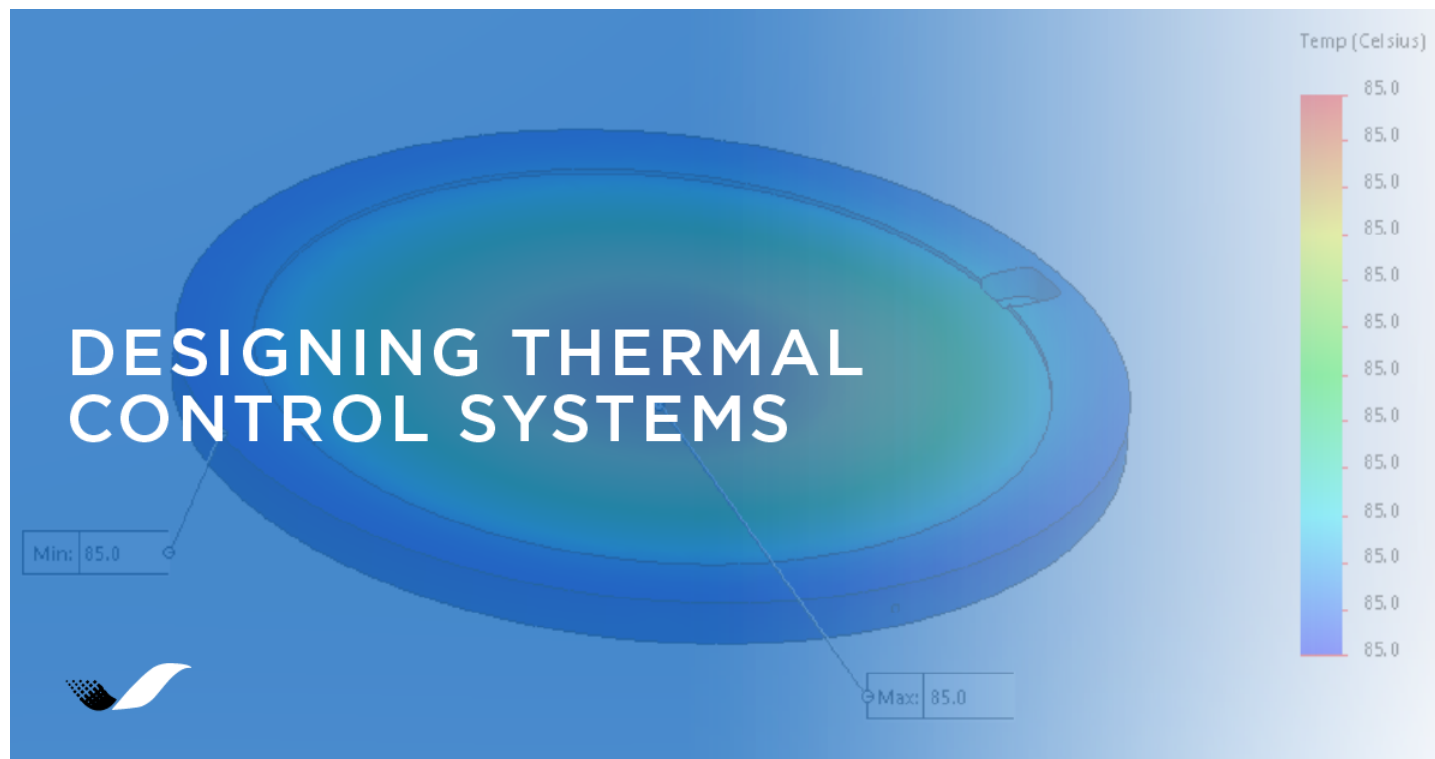
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August 30, 2017 | by Gerold Firl



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analysis, and diagnostic processes. Minimizing rise time is also key.

When time is money, throughput is the bank. Simplexity Product Development understands the engineering and economics of thermal processes.

## Thermal control system basics

Thermal control systems usually consist of four components: a heat source, a heat spreader, a temperature sensor, and a controller.

Sometimes we combine components; the heater can also be used as the temperature sensor, and the sensor can be considered part of the controller. But in one form or another, those components all need to be there. The trick is putting them together to get maximum performance, minimum cost, and the shortest possible lead time.

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solution, temperature, and time were the critical parameters for getting the coating right. A simplified version of the components is used here to illustrate precise thermal control.

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Using a 12-inch mini heater makes it a lot easier to get uniform temperatures together with a fast rise time. Using a cartridge heater is also an option, but then the heat source is more concentrated, which can result in hot spots. Using a thicker heat spreader mitigates temperature variation, but it also creates greater thermal mass and longer rise times.

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Steady-state thermal model of temperature distribution in heat spreader. Variation is less than 0.1 °C on the surface of the wafer nest, due to the conductivity of the plate and the distributed heat source.

The 85 +/- 1 °C temperature spec applies over the entire surface of the wafer nest. A small part of the [error budget](#) is consumed by variation within the heat spreader, but other error sources are more significant. The type-K thermocouple is cheap and readily available and has an accuracy of 0.4 °C. Getting accurate temperature feedback is a bigger problem than uniformity, but perfect is the enemy of good enough.

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## Other factors in thermal control

Another factor mentioned only in passing is rise time. Normally we think of it in terms of throughput, but for this system a more significant factor was control of fluid bath exposure time.

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*Wafer nest temperature profile. With a 1000 W heater, it takes 15 seconds to reach 84 °C.*

To get faster rise time, we can either use a more powerful heater or a thinner heat spreader. For low-volume production tools, custom components (like film heaters) are not only more costly, but a supply risk if replacements are needed. Sometimes it's worth it, but for this



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on the top surface of the wafer.

Fabrication experience can make all the difference. It's important to use stress-relieved aluminum for the heat spreader, because material with internal residual stresses can warp after machining. [K100S aluminum](#) is very stable, even after asymmetric machining, preferred when flatness is critical.

It helps that the contact is wet – and it's essential to prevent air pockets in the contact film – but we still need to use an optical IR thermometer for verification.

After processing chemistry is complete, a rinse cycle uses deionized water to clean the wafer and flush the process reagents. After that, the lid is opened, the wafer is removed, and a fresh wafer is inserted. It's a

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For any questions related to thermal control, please contact us at [info@simplicitypd.com](mailto:info@simplicitypd.com).

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