

# APPLIED MATERIALS SILICON SYSTEMS GROUP BECAUSE INNOVATION MATTERS™

## Applied Vantage® Vulcan™ RTP System

Applied extends the decade-long leadership of its Vantage system in rapid thermal processing with the Vantage Vulcan RTP advanced spike anneal system. RTP represents a roughly \$500M annual equipment market for Applied.

Annealing is used often during semiconductor device manufacturing to activate implanted dopants or change the state of materials to enhance desired attributes, such as conductivity. With progressive scaling down of devices, RTP has faced several growing challenges. A major one for spike annealing is minimizing temperature variations arising from differences in radiant energy absorption within a die.

As ramp rates have increased to reduce total thermal budget, the impact of the wafer's pattern on energy absorption and emission is increased, with yield-limiting consequences. Customers must routinely change device design rules in an attempt to compensate for this effect. Areas on the wafer that are more densely populated with silicon-based materials will absorb and emit more energy than oxide-based material, creating "hot spots" within each die.

As devices scale to the 28nm node and below, there has been a simultaneous trend to larger die sizes, making the pattern loading effect more pronounced. The Vantage Vulcan RTP system addresses these challenges through ingenious redesign of the RTP chamber, with heating lamps under the wafer and heat sensors above. Heating the device region through the smooth, uniformly absorptive back side of the wafer produces less than 3°C of temperature non-uniformity within each die and enables customers to improve yield.

An additional challenge with device scaling is the need to form shallower device junctions after implant doping of the source/drain regions. The Vantage Vulcan RTP system accomplishes faster temperature spikes, with residence times reduced to approximately 1 second. These sharper spike anneals can enable faster chip speeds by reducing junction diffusion depth without compromising activation.

Minimizing the thermal budget while sustaining minimum reaction temperatures (metal anneals) necessitates low-temperature (<200°C) anneals. With transmission-based sensors, the Vantage Vulcan system is the first RTP lamp product with closed-loop capability at near room temperature. Multi-point measurement produces superior wafer-to-wafer repeatability. This capability will enable the Vulcan chamber to provide unique solutions for low-temperature (<200°C) applications.

The Vantage Vulcan RTP system offers an energy savings benefit over previous systems, with an advanced design that makes more efficient use of grid electricity. The annual carbon footprint savings per system is equivalent to taking four mid-size sedans off the road.

The Vantage Vulcan RTP system delivers the industry's best-in-class spike anneal temperature uniformity and faster ramp times for higher device yield and performance. The system features the widest process control range (150°C–1300°C) of any RTP system, offering versatility for diverse advanced applications.