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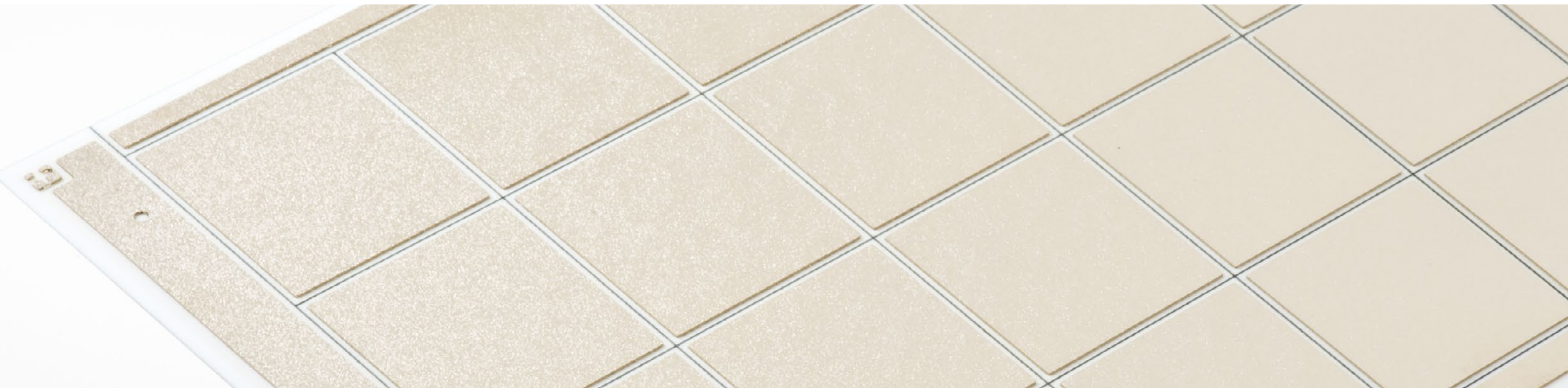
ENABLING POWER EFFICIENCY



curamik® SUBSTRATES for Silver Sintering

tech note

Silver sintering is a promising technology for high temperature power electronics packaging. It is becoming an attractive alternative to soldering, especially for high temperature applications and high reliability. Common die attach technologies are based on soft solders with melting points below 250°C. As long as the operation temperature of the semiconductor devices is limited to temperatures well below the melting point Tm of the used materials (e.g. Tm=183°C for Sn60Pb40 and Tm=221°C for SnAg3.5) soft solders have been the materials of choice for a reliable chip-to-substrate interconnect in power electronics packaging. With the development of new generations of semiconductors (e.g. based on wide band gap materials like SiC and GaN), the operation temperature will increase up to more than 200°C. This will lead to a significant decrease of the solders' strength and reliability (solder fatigue).

Definition:

// Sintering is a combined surface, volume, and grain boundary diffusion process

// Several processes (densification, grain growth, pore growth / coarsening) take place in parallel

Key Material Properties:

// Ag thermal conductivity 240 W/mK

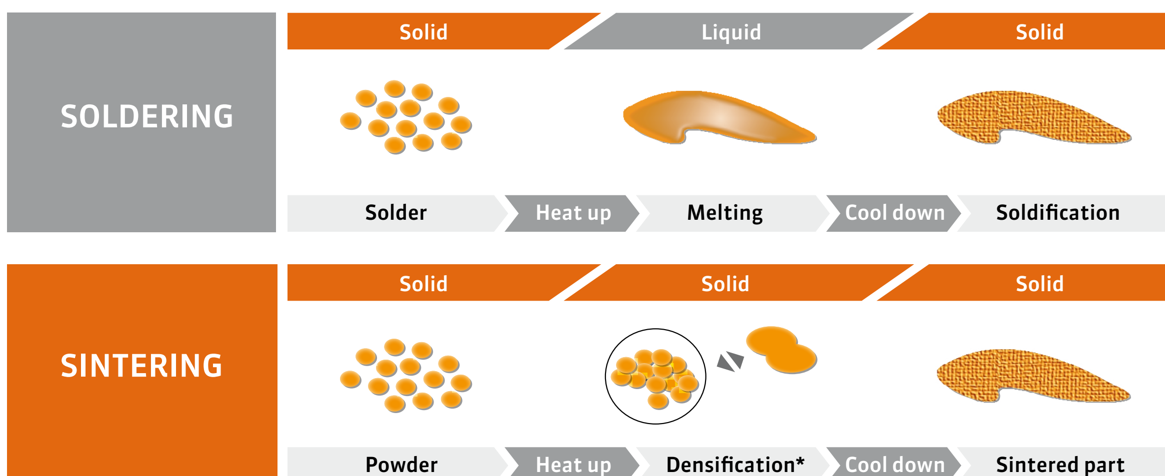
// Sintering joint thickness in the range of 50 to 100µm (lower possible)

// Ag melting temperature 961°C

Advantages:

// Improved heat dissipation from semiconductor devices

// Increased reliability



* by diffusion

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Process Flow (e.g. for silver pastes with micro particles)

Process	Stencil Printing	Drying	Die Pick and Place	Sintering
Equipment	conventional printing equipment	conventional box oven	die placer with heated tooling	sinter press
Parameter	standard parameter	drying in air 10 min. at 100°C	die placement temperature 120°C	sinter pressure 5-30 Mpa sinter temperature 230°C sinter time 3 min. in air

Key Parameters for reliable Sintering Joints

Substrate	metallization and metallization thickness, Plating process, Surface texture (roughness, waviness), Surface contaminations
Die	metallization, size
Silver paste	nano particles, micro particles printing, dispensing, laminating
Die pick and place and paste drying	void ratio, porosity, temperature
Sintering profile	time / temperatur / pressure heat up / cool down
Sintering atmosphere	air, nitrogen

Silver Pastes

Paste = silver powder mixed with additives (thinner, binder, dispersant)

Silver powder **particle size** ranges from few nanometres up to micrometres. Reducing the particle size results in higher specific surface (more particle surface per powder volume), thus accelerates the diffusion process. Typically the additives / organic residues are removed by applying **heat treatment prior to die placement.**

This additional process step is mandatory for micro particles based silver paste. It can be skipped for nano particles based silver paste.

designhouse

curamik® Solution

- // All curamik® products in any ceramic grade (Al_2O_3, HPS, AlN, Si_3N_4) and any material combination according to design rules are suitable for silver sintering process.
- // Ag and Ni/Au surfaces are recommended to achieve the best adhesion of silver pastes on DBC and AMB substrates.
- // Depending on process parameters, substrates with reduced roughness (Rz < 10µm instead of Rz < 16µm) may help to improve both process ability and reliability.
- // Selective Ag plating is also available for applications where only the semiconductor devices have to be sintered while the remaining area is bare copper to enable wire bonding.

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