Ag-Sintering of bare dies for power devices as an alternative to AuSn soldering

Ralph Schachler
Chemnitzer Seminar, 13.06.2018

Precision Matters.

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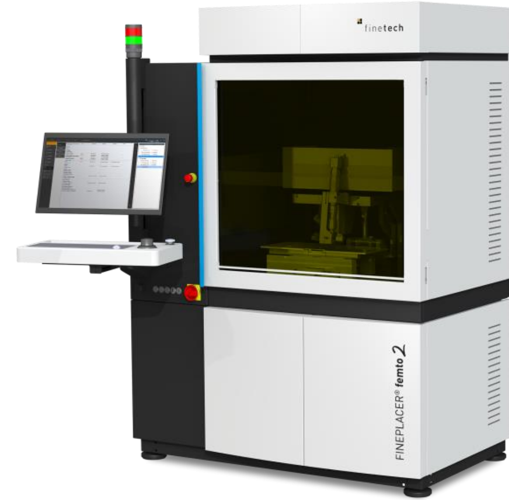
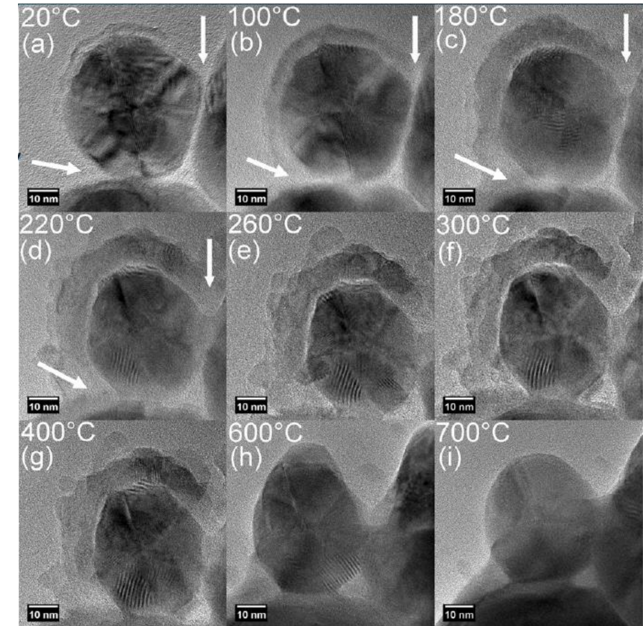


Prototype to Production

Flexible | Solution-driven | Accurate

Mechanism of sintering

- Paste or foil contains micro and nano particles e.g. of silver
- High temperature and pressure starts diffusion
  - Boundaries of particles contain a lot of energy
  - Joining of particles reduces this energy (physical background)
  - The smaller the particles the easier the sintering process
- Modern sintering materials contain nano scale particles



Copper Nanoparticle-Based Interconnect for 3D Heterogeneous Integration
Henk v. Zeijl, ECTC 2016

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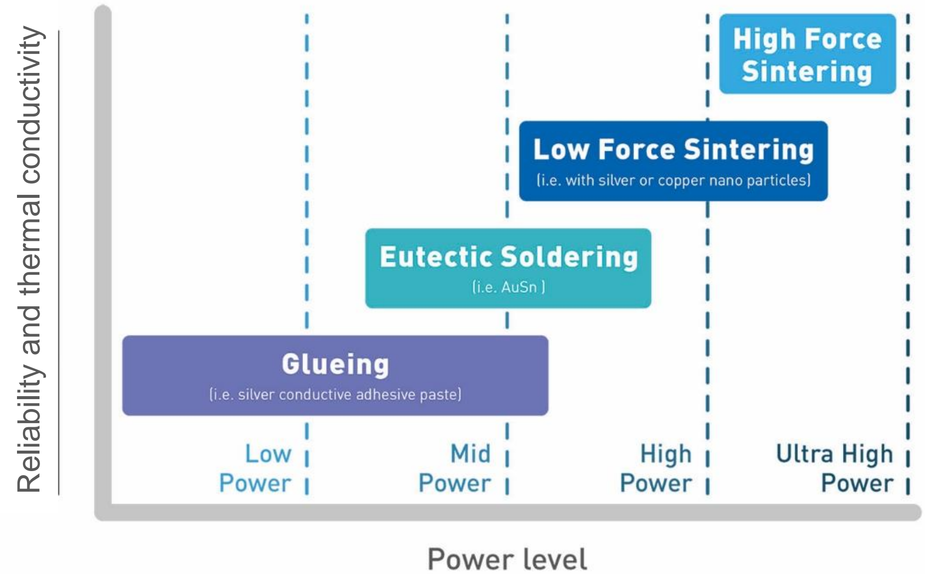
Demands for High Power Applications

- High Conductivity (therm., elec.)
- High Operation Temperature
- Long Life Time
- Area of Application: Power Modules for
  - Wind Turbines
  - Solar Tower Panels
  - Electric Vehicles
  - Laser Diodes/Bars

High Placement Accuracy



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Properties of Ag-sintered and soldered bonds

Material	CTE [10^{-6}/K]	Thermal Conductivity [W/mK]	Electrical Resistance [µΩcm]	Melting point [°C]
Ag (solid)	20	429	1.6	962
Ag (sintered)	19	**100 to 300**	**2 to 8**	**962**
Au80Sn20	16	57	16	>280
SAC305	22	55	14.5	217

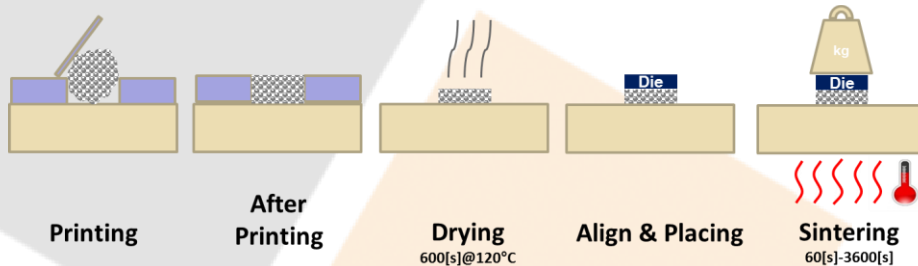
Remark: Values may vary depending on source.

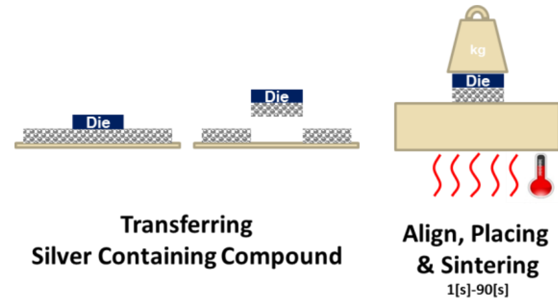
Powerful alterative!

Standard for High Power Applications

Paste vs. foils

Paste	Foil
Low material price	No tooling (stencil) necessary
Mature technology	High performance of bond
	No post sintering necessary
	No drying and shrinking





Typical process parameters

	Sinter Paste	Sinter Foil
Material	Ag	
Properties	Pasty	Solid
Compossible Material	Cu, Au, Ag	
Pre-Process Time (typ.)	≈ 600 s	≈ 10 s
Process Time (typ.)	≈ 1 to 90 s	
Post-Process Time	up to 3600 s	n.a.
Temperature (typ.)	≈ 200 to 300 [°C]	
Pressure (typ.)	„0“ - 30 [N/mm²]	5 - 30 [N/mm²]

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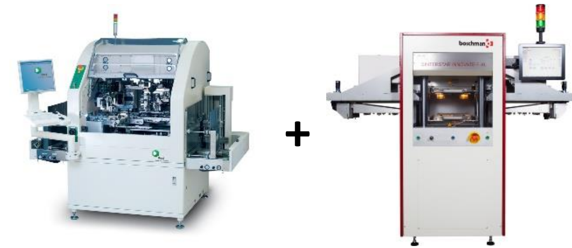
Finetech's approach for Ag sintering for R&D and low volume

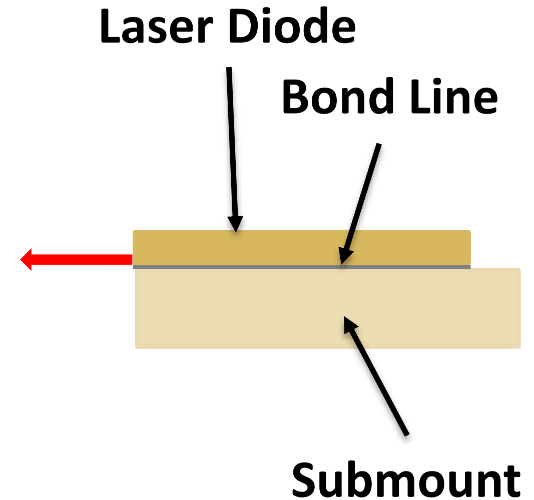


- Usual approach: Placement on diebonder and sintering in sinter press
  - ➢ Very high investment for R&D or low volume!

- FINEPLACER®s can apply high forces (e.g. up to 1000 N)
  - ➢ Complete sintering process on one machine → less investment
- FINEPLACER®s reach a very high placement accuracy
  - ➢ E.g. suitable for High Power Laser Diodes

Foil sintering of High Power Laser Diodes

- Task: Bond laser diode on submount
  - Die size: 0.6 x 5 mm²
- Challenges:
  - Accuracy in µm range (edge to edge, not scope of these tests)
  - No pollution at facette → accurate lamination of sinter foil to chip
  - Optimal bond line condition (not in scope of these tests)
- Process parameters
  - Temperature 300°C
  - Force 90 N → rather high force to be on the safe side
  - Time 100 s



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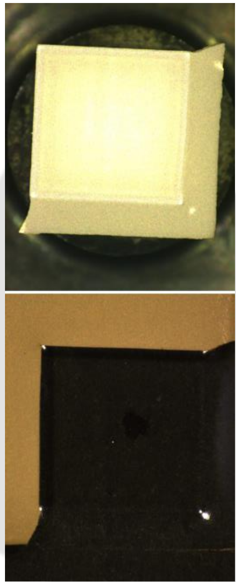
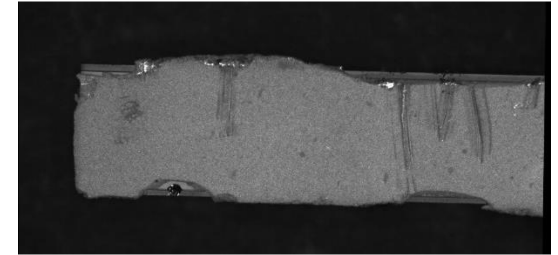
Foil sintering of High Power Laser Diodes

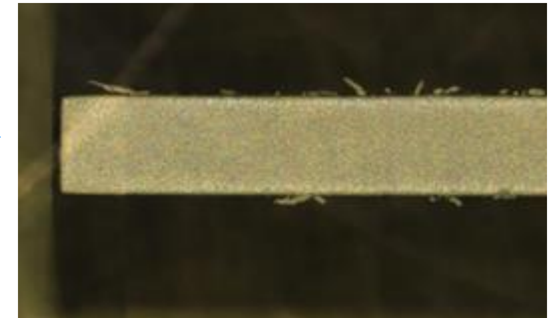


No pollution on facette:

- Foil can break and excess material is laminated to the chip
- Incomplete lamination to chip



- Solution:
  - Semi-soft support for foil improve sharpness of imprint in foil
  - Press on rubber plate to cut off excess material after lamination

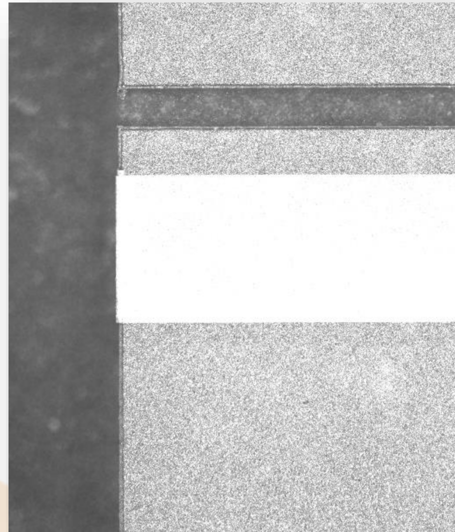


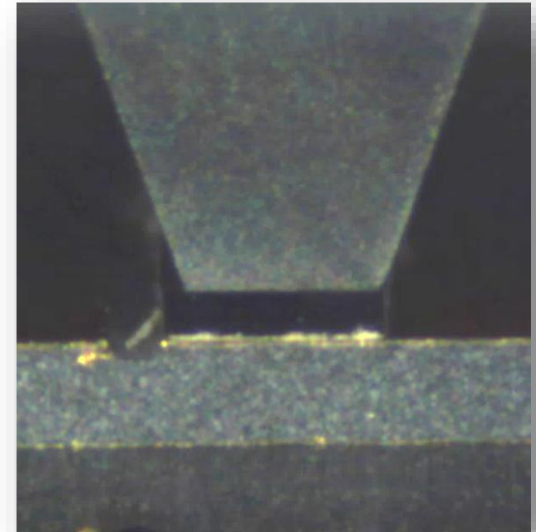
Foil sintering of High Power Laser Diodes

Results:

- Perfect alignment in µm range
- Clean facettes
- Sufficient adhesion (die breaks in shear test)

Foil sintering process success-fully set up at customers!





Conclusion

- Ag sintering is a suitable for
  - High power application
  - High temperature applications
- Ag foil sintering is rather new, but processes have been set up successfully
- FINEPLACER®s are a good alternative for R&D and low volumes

Questions?