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Formulation and processing of screen-printing vehicles for sacrificial layers on thick-film and LTCC substrates

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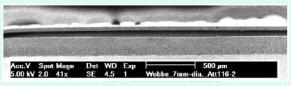
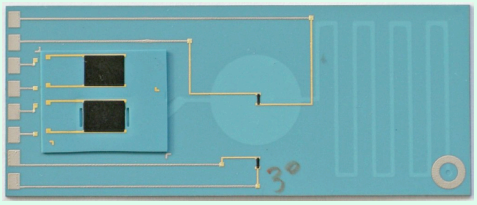
Sacrificial layers = new possibilities for thick-film & LTCC devices… *but involve processing issues!*

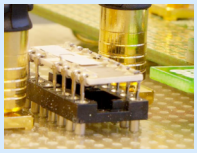
LTCC channels + membranes (carbon):
- Fluidics + microchemistry
- Pressure sensors
- Viscosity sensors
- (also for classical thick-film)

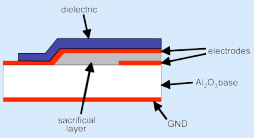




LTCC gas viscosity sensor [3] & SEM of membrane

Thick-film cantilevers & bridges (mineral):
- Hot-filament thermal sensors
- Sensors for very low forces
- Piezoelectric & electrostatic actuators
- (also for LTCC)



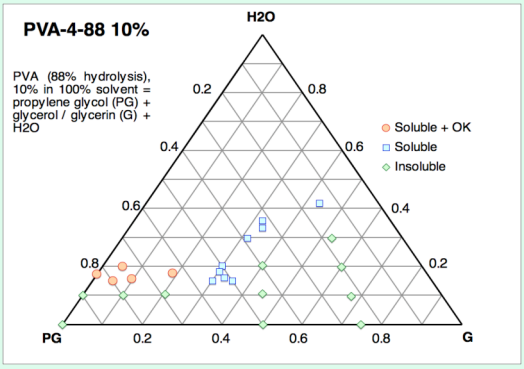


Capacitive microforce sensors (dielectric cantilever) [1,2]

Use of standard vehicles for carbon layers:
- OK with thick LTCC tapes **only**
- Destruction of thin (50 µm) tapes
- Incompatibility due to dissolution / softening of LTCC binder in vehicle solvent

Printing cantilevers / bridges onto sacrificial layer:
- Onto fired layer: premature drying of paste
- Onto dried layer with classical vehicle : premature drying
- Onto dried layers + epoxy : OK, but poor process flow compatibility (cleaning, …) with standard vehicles

➜ PVA - glycol-based vehicle
- Polyvinyl alcohol (PVA) binder
- Propylene glycol (PG) - glycerol (G) - water (H_2O) solvent
- Negligible interaction with LTCC
- Non-toxic, low environmental impact



Binder (10% PVA) solubility map in PG-G-H_2O system

IMPORTANT: minimise water content!
1) Avoid dissolution of PVA-based screen emulsion
2) Keep evaporation low

➜ Classical vehicle with high "non-evaporable" content
- Binder = ethylcellulose (EC, 48% ethoxyl, "4 cP" grade)
- Low molecular weight grade allows high concentrations
- Additional "non-evaporable" content by adding triethylene glycol bis 2-ethylhexanoate (TEG-EH) → plasticiser

Binder	Ethylcellulose (EC), "4 cp" grade	20%
Solvent	Terpineol	40%
	N-methyl-2-pyrrolidone (NMP)	30%
	Triethylene glycol bis 2-ethylhexanoate (TEG-EH)	30%

Optimised concentrations (approx.)

Conclusions
- Screen printing vehicles developed for two key processes
- Now in application & extensive testing
- Needs to be further refined
- Allows / facilitates novel thick-film & LTCC structuration techniques

References
1) Fournier-Y Wiedmer-S Maeder-T Ryser-P, "Capacitive micro force sensors manufactured with mineral sacrificial layers", Proceedings, 16th IMAPS European Microelectronics & Packaging Conference (EMPC), Oulu, Finnland, pp. 298-303, 2007.
2) Maeder-T Fournier-Y Wiedmer-S Birol-H Jacq-C Ryser-P, "3D structuration of LTCC / thick-film sensors and fluidic devices", Proceedings, 3rd International Conference on Ceramic Interconnect and Ceramic Microsystems Technologies (CICMT), Denver, USA, pp. THA13, 2007.
3) Maeder-T Dumontier-N Jacq-C Corradini-G Ryser-P, "LTCC Gas-Viskositätssensor", Proceedings, IMAPS Deutschland Konferenz, München, DE, 2007.