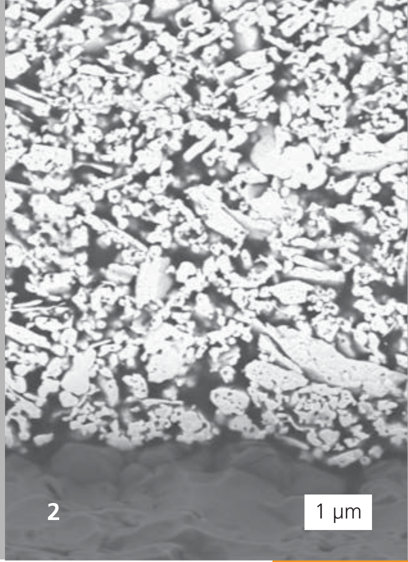

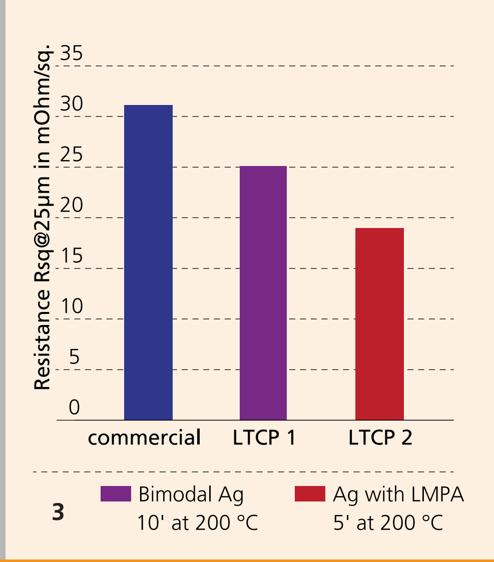

FUNCTIONALIZATION OF CERAMIC THICK FILMS AT 200 °C

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Ceramic thick-film technology enables the creation of electronic circuits on ceramic substrates from different materials (silicon nitride, silicon carbide, glass, steel). The layers can be adjusted with regard to different properties. By means of high-resolution depositing methods, conductive, resistance or isolation layers can be printed and burnt variably and highly selective. Conventional thick-film pastes require firing temperatures of about 850 °C. Therefore, substrates, which are sensitive to high temperatures, like polymers, tapes or ITO layers cannot be functionalized with conventional pastes. IKTS develops special pastes on the basis of polymers, which thermally harden at 200 °C and are mixed with a functional phase, for this range of applications. Depending on the application requirements, the functional phase can be silver or copper for conductive pastes or carbon in various modifications (carbon black, graphite, carbon nanotubes) for resistor pastes.

Using conductive pastes (LTCP – Low Temperature Conductor Pastes), a sheet resistance of 25 mΩ/□ can be reached using a curing time of 10 minutes at 200 °C. The conductivity in this composites is adjusted with the amount of percolation between conductive particles using powders that have a bimodal particle size distribution (Figure 2, Figure 3 – LTCP 1). As an alternative, LMPA powders (Low Melting Point Alloy) can be used. These powders melt during curing and generate additional conductive paths between the metal particles. With these pastes, the resistance can be decreased to 19 mΩ/□ using a curing time of just 5 minutes at 200 °C (Figure 3 – LTCP 2). These paste systems are currently used for the fabrication of high-efficiency MWT+ solar cells (Metal Wrap Through) [1] as shown in Figure 1.

Applications in the field of sensors often require functional layers with a well-defined electrical resistance. At IKTS, pastes (LTRP – Low Temperature Resistor Pastes) with different kinds of carbon modifications as functional phase are prepared and optimized. The layers can be adjusted within a broad resistance range from 103 – 106 Ω/□. For example, strain gauges with high sensitivity to length variation are a possible application for polymeric resistor pastes. The resistor pastes developed by IKTS have a resistance of 2 MΩ/□ and a gauge factor of up to 16.

Besides thermal curing, thick-film pastes with a polymer basis offer the possibility of hardening without thermal stress for the substrate. Therefore, flashlights are used or photochemical curing by UV light is induced. Using this kind of curing requires adjusted organic vehicles. For conductive pastes, inductive curing is another approach. Using low hardening temperatures facilitates the creation of circuits and sensors on substrates, which cannot be processed with conventional ovens due to large dimensions. Sensors can be selectively and directly applied onto a substrate due to this innovative curing technology. With this technique, the retrofit for already existing systems, like wind wheels, is a possibility.

References

[1] I. Dirnstdorfer et al., Development of Silicon Heterojunction Metal Wrap Through Solar Cells, Proceedings PVSEC, 2014.

1 *MWT+ solar cell with conductor paste based on silver filled polymer.*
2 *Polished cross section of MWT+ solar cell conductor path.*
3 *Conductive resistors of different low-temperature pastes depending on curing duration and composition.*

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