



ISO 9001:2000 registered. Established in 1988.

THICK FILMS

A. Thick Film Technology

In addition to our Thin Film Technology, we offer Thick Film Technology. In comparison to the thickness in Angstrom or m units of the thin film, the typical thickness of the thick film is 12.5 m (.0005"). While the thin film is deposited in a vacuum system, the thick film is screen printed followed by firing at a high temperature. One exception is a polymer based thick film that requires a low temperature curing.

Oxide Ceramic or Glass:

The popular thick film contains about 85% metallic elements (powders or flakes) with 5% of inorganic high temperature binder (either glass, ceramic or a combination of both). One of the most popular thick films is a 6-12.5 μm thick Ag or Au paste on a 96% alumina substrate. The Ag thick film has higher electrical resistance than a pure Ag. In the thick film process, the adhesion of the thick film comes from the binder and not from the metallic element. One drawback of this type of metallization is low adhesion strength. In addition, the thick film may not be hermetic due to the non-hermetic nature of the metallization of the metallic powder or flake presence.

A thick film can be applied on: alumina, zirconia, glass-ceramic (Macor, a Corning product), Cordierite, Forsterite, Steatite, Mullite and others. The firing process requires an oxygen rich atmosphere so that the binding system remains in a full stoichiometry. Alumina substrate throughout the IJ Research process maintains their original shapes with no warping or distortion and it retains its original flatness.

If the substrate has low stability temperature, the binder of the thick film process must be changed to lower the process temperature.

IJ Research uses commercially available thick films pastes made in the United States. IJ Research has the capability of formulating a thick film paste that can be cured at as low as 450C or as high as 1200C. We use Ag, Ag-Pd, Au, Cu, Ni, Ag-Pt and Pt. Of these elements, Cu and Ni are fired in an oxygen poor atmosphere in order to avoid the oxidation of the elements. The Cu or Ni processes require that the inorganic binder contains a strong bonding energy. They must not be reduced in a protective environment.

Non-oxide Ceramics:

IJ Research uses pastes for nitrides, carbides and boride ceramics. Many of the commercially available pastes are less than satisfactory for nitrides, carbides and borides. We formulate suitable mixes for these non-oxides. We also offer hermetically sealable thick film metallization on AlN, Si₃N₄, SiC and many more nonoxides. AlN can be hermetically sealed to a ceramic or metal. We can then apply a pattern that is solderable, brazable and/or wire bondable.

Resistive Patterning:

If the application is for resistive patterning, the formula of the paste will have a resistive element with the same binder types. A paste will be formulated for any application including: chemical resistance, high temperature, high pressure, and thermal shock resistance.

Metallic Substrate:

The above pastes can be applied on a metallic substrate as long as it has a dielectric layer first. One of the most important features of this dielectric layer is its thermal expansion coefficient (CTE). The CTE must be closely matched and the thickness must be thin in order to minimize an interfacial thermal stresses.

For example, if the dielectric layer is to be applied to Aluminum, the dielectric layer's CTE must be closely matched to that of Al. If it is SST 300 series, the CTE must again match that of the stainless steel. The melting points, specific heat, and others must also be considered for success with these products.

IJ Research can formulate the binder system to match Cu, Al, SiO₂, zirconia, SST 300 series, SST 400 series, Ni alloy, steel, and many other metals and alloys.

Dielectric layer:

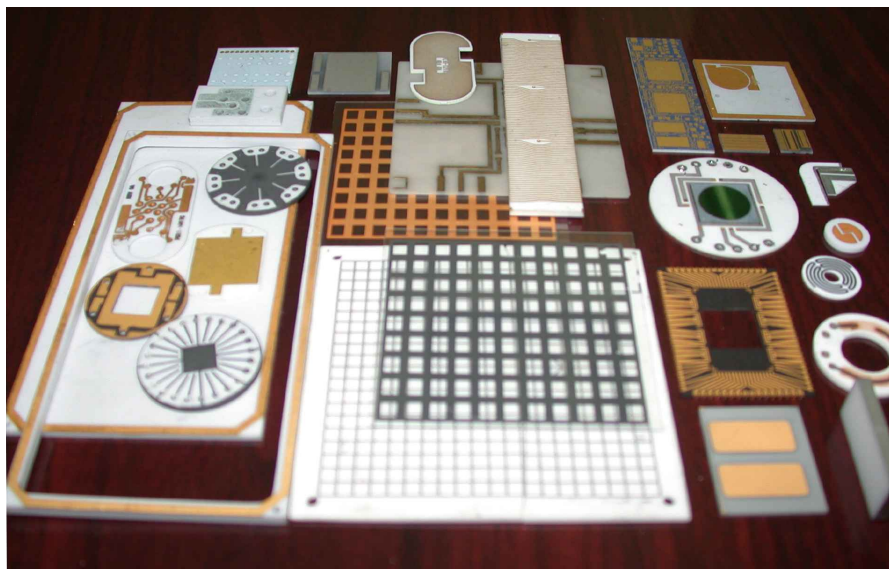
IJ Research has the capability of applying a dielectric layer on top of the resistive or conductive patterns.

Combination of thick and thick films: IJ Research offers the combinations listed below:

- Thick film on ceramic and then multi-layers of thin film.
- Thin film on ceramic and dielectrically and hermetically sealed to another material.
- Thin film on polymer with a thin film polymer on top.
- Thick film dielectric layers on non-oxide or oxide ceramics followed by thin film (either resistive or conductive).

(Continues)

T H I C K F I L M S



B. Thick Film Heater Technology

IJ Research's thick film heaters contain the most up-to-date material. The thick film pastes or inks are used in precision heating systems.

Our custom designed heaters are directly printed on glass, ceramic or metal. The heaters combine highly conductive or non-conductive ceramics or metals/alloys for thermal performance and efficiency. Our FEA program controls the heat transfer so that our actual heater products are well within the customer's specification. Heaters are made on flat substrates as well as on the inside or outside of tubing. Spiral patterns can also be printed. We can print any pattern on a flat substrate and control the power density with precision. Power densities within .002 W/cm² are routine at IJ Research.

We coat our stainless steel substrates with dielectric layers before we print a heater pattern. In recent years, the semiconductor

industry has required using nitride ceramic boards in their inspection and processing equipment with heaters built-in. In order to meet these new specifications, IJ Research continues to improve on each current job as well as with new development.

Most of the common pastes are as follows:

- All the commercially available blends of Ag, Ag-Pd, Ag-Pt, Au, Cu, Ni and few others are routinely used in IJ Research for oxides, nitrides, carbides as well as borides.
- Cermet resistive paste with inorganic vehicle. Our resistive elements are metal/ceramic mixtures (cermet). They include Ruthenium Dioxide (RuO₂), Bismuth Ruthenate (Bi₂Ru₂O₇), Bismuth Iridate (Bi₂Ir₂O₇), and Lead Oxide (PbO).
- Cermet resistive paste with organic binder.
- Overglaze dielectric pastes (impervious vitreous layer).
- Dielectric coating blends for stainless steel, Al alloy or Cu.

- IJ Research's dielectric ceramic coating process on metal/alloy (impervious crystalline layer) (Patented).

IJ Research's ceramic fabrication plant has production capability of 12" x 12" x various thicknesses with flatness +/- .001" across the entire length of alumina 96% to 99.8%.

This capability of maintaining such high quality flatness enables us to supply large substrates and manage high volume screen printing jobs with high yield.

Applications are unlimited in the heater field. IJ Research is a well-known heater supplier for the industries of: microelectronics, instrumentations, wireless telecommunication, medical, defense sensors, detectors and semiconductor equipment. IJ Research is a source for complex requirements of conductors (and their terminations) with various heater designs and conductor paths.



C. Final Note:

In thick film family, IJ Research offers the following technologies along with the above:

- Cu/Ni or TiCrO₅ conductive or resistive layers
- Mo or W resistors or conductors
- Polyimide coatings in addition to glass or ceramic coatings.

Please contact one of our Applications Engineers for any questions you might have on the subject.



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