process. A stamp-making material can be applied onto the ink pattern of the master tool to form a stamp having a stamping pattern being negative to the ink pattern. A stamping surface of the stamping pattern can be inked with an ink composition and contacted with a metalized surface to form a printed pattern thereon according to the stamping pattern. Using the printed pattern as an etching mask, the metalized surface is etched to form electrically conductive traces.

In one aspect, there is provided a method comprising: screen-printing an ink pattern onto a major surface of a master tool, the ink pattern comprising a plurality of ink pattern elements extending away from the major surface and one or more indentations formed between the respective ink pattern elements that are adjacent to each other; and applying a stamp-making material to the major surface of the master tool to form an elastomeric stamp having a stamping pattern, the stamping pattern being negative to the ink pattern of the master tool, the stamping pattern comprising a base surface and one or more stamping pattern elements extending away from the base surface, the stamping pattern elements corresponding to the indentations of the master tool, and each of the stamping pattern elements having a stamping surface, wherein at least one of the ink pattern elements has a relief height of at least 10 micrometers.

In one embodiment, a method includes screen-printing an ink pattern onto a major surface of a master tool. The ink pattern includes a plurality of ink pattern elements extending away from the major surface and one or more indentations formed between the respective ink pattern elements that are adjacent to each other. A stamp-making material is applied to the major surface of the master tool to form an elastomeric stamp having a stamping pattern. The stamping pattern is negative to the ink pattern of the master tool. The stamping pattern includes a base surface and one or more stamping pattern elements extending away from the base surface. The stamping pattern elements correspond to the indentations of the master tool, and each of the stamping pattern elements has a stamping surface.

There is also provided a method of forming an electrically conductive pattern on a substrate is provided. The method includes providing a master tool having an ink pattern on a major surface of a master substrate thereof. The ink pattern includes a plurality of ink pattern elements extending away from the major surface and one or more indentations formed between the respective ink pattern elements that are adjacent to each other. A stamp-making material is applied to the major surface of the master tool to form an elastomeric stamp having a stamping pattern. The stamping pattern is negative to the ink pattern of the master tool. The stamping pattern includes a base surface and one or more stamping pattern elements extending away from the base surface. The stamping pattern elements correspond to the indentations of the master tool, and each of the stamping pattern elements has a stamping surface. The method further includes inking the stamping surfaces of the stamp with an ink composition. The stamping surfaces of the stamp are contacted with the metalized surface of the substrate to transfer the ink composition from the stamping surfaces of the stamp to the metalized surface and create a printed pattern thereon. The method further includes etching, using the printed pattern as an etching mask, the metalized surface to form one or more electrically conductive traces on the substrate.

In another aspect, there is provided a method of forming an electrically conductive pattern on a substrate, comprising: providing a master tool having an ink pattern on a major surface of a master substrate thereof, the ink pattern comprising a plurality of ink pattern elements extending away from the major surface and one or more indentations formed between the respective ink pattern elements that are adjacent to each other, wherein the ink pattern is screen-printed onto the major surface of the master substrate, and at least one of the ink pattern elements has a relief height of at least 10 micrometers; applying a stamp-making material to the major surface of the master tool to form an elastomeric stamp having a stamping pattern, the stamping pattern being negative to the ink pattern of the master tool, the stamping pattern comprising a base surface and one or more stamping pattern elements extending away from the base surface, the stamping pattern elements corresponding to the indentations of the master tool, and each of the stamping pattern elements having a stamping surface; inking the stamping surfaces of the stamp with an ink composition; contacting the stamping surfaces of the stamp with a metalized surface of the substrate to transfer the ink composition from the stamping surfaces of the stamp to the metalized surface and create a printed pattern thereon; and

etching, using the printed pattern as an etching mask, the metalized surface to form one or more electrically conductive traces on the substrate.

Claims

What is claimed is:

1. A method comprising:

screen-printing an ink pattern onto a major surface of a master tool, the ink pattern comprising a plurality of ink pattern elements extending away from the major surface and one or more indentations formed between the respective ink pattern elements that are adjacent to each other; and

applying a stamp-making material to the major surface of the master tool to form an elastomeric stamp having a stamping pattern, the stamping pattern being negative to the ink pattern of the master tool, the stamping pattern comprising a base surface and one or more stamping pattern elements extending away from the base surface, the stamping pattern elements corresponding to the indentations of the master tool, and each of the stamping pattern elements having a stamping surface,

wherein at least one of the ink pattern elements has a relief height of at least 10 micrometers.

2. The method of claim 1, wherein at least one of the ink pattern elements has a lateral dimension of at least 30 micrometers.

3. The method of claim 1 or 2, wherein at least one of the ink pattern elements has a draft angle of 0 to 10 degrees.

4. The method of any preceding claim, wherein screen-printing the ink pattern further comprises providing a screen having a screen pattern thereon, the screen pattern comprising open areas configured to allow fluid to pass through the screen, positioning the screen adjacent to the major surface of the master tool, and applying ink to pass through the open areas of the screen to form an ink pattern on the major surface of the master tool.

5. The method of claim 4, wherein providing the screen further comprises providing a photosensitive emulsion layer on the screen, and exposing the photosensitive emulsion layer via a photomask to develop the screen pattern thereon.

6. The method of claim 5, wherein the photosensitive emulsion layer comprises a photosensitive material including polyvinylacetate, poly vinyl alcohol, acrylate monomer, or a combination thereof.

7. The method of any preceding claim, wherein the stamp-making material includes uncured polydimethylsiloxane (PDMS).

8. The method of any preceding claim, wherein the master tool comprises a glass substrate, and the ink pattern adheres to the glass substrate after curing or drying a ceramic high-temperature ink.

9. The method of any preceding claim, wherein at least one of the stamping surfaces has a lateral dimension of at least 30 micrometers.

10. The method of any preceding claim, wherein at least one of the stamping pattern elements has a characteristic height of at least 10 micrometers.

11. A method of forming an electrically conductive pattern on a substrate, comprising:

providing a master tool having an ink pattern on a major surface of a master substrate thereof, the ink pattern comprising a plurality of ink pattern elements extending away from the major surface and one or more indentations formed between the respective ink pattern elements that are adjacent to each other, wherein the ink pattern is screen-printed onto the major surface of the master substrate, and at least one of the ink pattern elements has a relief height of at least 10 micrometers;

applying a stamp-making material to the major surface of the master tool to form an elastomeric stamp having a stamping pattern, the stamping pattern being negative to the ink pattern of the master tool, the stamping pattern comprising a base surface and one or more stamping pattern elements extending away from the base surface, the stamping pattern elements corresponding to the indentations of the master tool, and each of the stamping pattern elements having a stamping surface;

inking the stamping surfaces of the stamp with an ink composition;

contacting the stamping surfaces of the stamp with a metalized surface of the substrate to transfer the ink composition from the stamping surfaces of the stamp to the metalized surface and create a printed pattern thereon; and

etching, using the printed pattern as an etching mask, the metalized surface to form one or more electrically conductive traces on the substrate.

12. The method of claim 11, wherein screen-printing the ink pattern further comprises providing a screen having a screen pattern with open areas thereon, applying ink to pass through the open areas of the screen to form the ink pattern on the major surface of the master substrate, and drying the ink pattern to form the master tool.

13. The method of claim 11 or 12, wherein at least one of the stamping pattern elements has a characteristic height of at least 10 micrometers.

14. The method of any one of claims 11-13, wherein at least one of the stamping surfaces has a lateral dimension of at least 30 micrometers.

15. The method of any one of claims 11-14, wherein at least one of the electrically conductive traces has a lateral dimension of at least 30 micrometers.

16. The method of any one of claims 11-15, wherein the master tool comprises a glass substrate, and the ink pattern adheres to the glass substrate after curing or drying a ceramic high-temperature ink.

17. The method of any one of claims 11-16, wherein the stamp-making material includes uncured polydimethylsiloxane (PDMS).

18. The method of any one of claims 11-17, wherein the ink composition comprises a functionalizing molecule, wherein the functionalizing molecule comprises a functional group capable of binding to the metalized surface of the substrate.

19. The method of any one of claims 11-18, wherein the substrate includes a polymeric film and a metal layer disposed on the polymeric film.

20. The method of claim 19, wherein the polymeric film comprises poly(ethylene terephthalate) (PET), poly(butylenes terephthalate) (PBT), poly(ethylerne naphthalate) (PEN), or a combination thereof.

21. The method of claim 19 or 20, wherein the metal layer includes at least one of copper, silver, aluminum, gold, and combinations thereof.