

Description

Background of the Invention

In order to provide capacitors which can be mass produced at low cost, and which have accurately controlled values, it is desirable to be able to adjust the value at the end of the manufacturing operations. Capacitors have been manufactured using thin film technology wherein one or more electrodes are trimmed, as by use of a laser, to adjust the capacitance value. However, this thin film technology requires the formation of metal and dielectric layers by deposition in a vacuum chamber. As masks must be used in the vacuum chamber to determine the patterns of the layers, the process requires the use of sophisticated and complicated equipment, and is slow and expensive.

Capacitors have also been made by using thick film layers which can be screened so that the process is relatively simple and inexpensive. Such capacitors are known from US Patents Nos. 3,192,086, 3,600,652 and 3,947,934. Such layers are much thicker, such as from 12 to 30 microns thick, as compared to one-third of a micron for thin film layers. Because of the thickness of the electrodes and the properties of the electrodes and dielectric materials, it has not been possible to accurately remove a portion thereof to adjust the capacitor value, without causing damage to the capacitor. Also techniques used with thin film capacitors, such as applying a voltage across the electrodes during laser trimming to prevent shorts, does not work with thick film capacitors as the large voltage required due to the dielectric thickness may exceed the dielectric strength of the dielectric material.

Summary of the Invention

It is the object of this invention to provide an adjustable thick film capacitor and a method of manufacture of adjustable thick film capacitors which is simple and inexpensive and wherein the value of the capacitor can be adjusted by laser trimming without damaging the capacitor.

According to the invention, there is provided a process for making a thick film capacitor including the steps of screening a first layer of conductive paste onto a substrate to form a first capacitor electrode,

drying the first conductive paste layer,

screening a second layer of dielectric paste over the first conductive layer to form a capacitor dielectric,

drying the second dielectric paste layer,

screening a third paste layer over the second dielectric layer to form a second capacitor electrode,

drying the third paste layer,

firing the first, second and third layers, and

trimming the third layer by using a laser beam to adjust the size of the electrode formed thereby and therefore the value of the capacitor,

characterised in that said third layer is screened using an organo-metallic paste providing mole-

cules containing conductive particles and in that the firing is continued until the third organo-metallic paste layer is reduced to form a layer of conductive particles, said layer having a maximum thickness of 2 microns.

According to the invention there is provided an adjustable thick film capacitor suitable for trimming by means of a laser beam, the capacitor comprising

a substrate having thereon a first conductive layer formed by a conductive paste which has been dried and fired to form a first electrode, said first conductive layer having thereon a dielectric layer which has been formed by a dielectric paste which has been dried and fired, and said dielectric layer having thereon a second conductive layer which forms a second adjustable conductive electrode, characterised in that said second conductive layer is formed by an organo-metallic paste which has been dried and fired, said organo-metallic paste having conductive particles therein which have been sintered to form a layer less than 2 microns thick formed by particles which engage each other.

A chip capacitor constructed as described can have plated conductors extending from the electrodes through recesses or holes in the chip carrier to terminal pads on the chip carrier for making connections to a circuit.

Brief Description of the Drawings

Fig. 1 illustrates the steps of the process of the invention;

Fig. 2 is an enlarged cross-sectional view of a capacitor constructed in accordance with the invention;

Fig. 3 is a perspective view of a chip capacitor constructed by the process of the invention; and

Fig. 4 is a bottom view of the carrier of Fig. 3.

Detailed Description of the Invention

Fig. 1 illustrates the steps of the process for making a capacitor in accordance with the invention, with drawings A through J showing the capacitor in the various stages of construction. Fig. 1A shows the substrate 10 which can be a part of a microelectric circuit, or the carrier of a chip capacitor. The substrate 10 can be made of alumina, or any other suitable material, and can have a thickness typically of the order of 10 to 25 mils. The layer 12 on the substrate 10 can be any known conductive paste, such as gold, platinum silver, platinum gold or palladium silver. This paste can be screened on the substrate 10 in the desired shape and can have a thickness of the order of 30 microns.

The paste 12 is allowed to dry so that the volatile portions of the screening vehicle evaporate and the tackiness is removed. Then it is fired at a temperature of the order of 850°C to 1000°C for a period of 5 to 10 minutes. The layer is reduced to the order of 26 microns by the drying operation, and is further reduced in thickness by the firing which sinters the dry paste into a dense metal layer which has a final thickness of the

order of 12 to 15 microns. Fig. 1B shows the substrate 10 with the fired conductive layer 12 hereon.

After the conductive layer 12 is fired, a layer 14 of dielectric paste is screened thereon, as shown by Fig. 1C. This should be a low-K glass dielectric composition, such as No. 9950 manufactured by E. I. DuPont DeNemours & Co., Wilmington, Delaware, or No. A-2835 manufactured by Engelhard Minerals and Chemicals Corp., East Newark, New Jersey. The dielectric layer 14 can have a thickness of the order of 30 to 40 microns when applied. This layer is allowed to dry, first at room temperature for 5 to 10 minutes, and then at 100°C to 125°C for 10 to 15 minutes. After drying, the dielectric layer is fired at a temperature of the order of 850°C to 950°C for 7 to 10 minutes. The layer 14 is reduced to a thickness of the order of 15 to 20 microns by the drying and firing operations, as shown by Fig. 1D.

It has been found that for best surface smoothness and minimum pinholes, a second layer 16 of dielectric paste should be applied, and this is shown by Fig. 1E. This layer can be of the same material and have the same thickness as the layer 14 when applied. This layer is also dried and fired and reduced in thickness. The total thickness of the two layers can be of the order of 30 to 45 microns, as shown in Fig. 1F. In the subsequent illustrations, the two layers 14 and 16 will be shown as a single layer.

After the dielectric layers 14 and 16 are fired, a second conductive paste layer is applied, as shown at 18 in Fig. 1G. This conductive layer is the top electrode of the capacitor device, and is not connected to the conductive layer 12. This is an organo-metallic paste which includes molecules having atoms of conductive metal, such as gold, platinum or palladium. Suitable materials for this use are Bright Gold No. A3725 and No. 6340 available from Engelhard Minerals and Chemical Corp. These are thick semi-gelled solutions which contain of the order of 15% to 18% gold. The layer 18 is screened on the dielectric in the desired pattern in a thickness of about 25 microns. After drying, the organo-metallic paste is fired at a temperature of about 850°C. This acts to sinter the paste so that very small gold balls, plates or particles are formed which contact each other forming a continuous conducting electrode. The firing reduces the layer to a thickness of no more than 2 microns, and preferably about 1 micron. This is illustrated in Fig. 1H, with the layer 18 being shown many times thicker than it is for better illustration.

The above steps produce a complete capacitor which can be tested. The dimensions of the electrodes 12 and 18 and the thickness of the dielectric 14, 16 can be selected to provide the desired value within broad limits. However, because of tolerances, where will be some variations in value. To take care of this, the dimensions are selected so that the value is on the high side and can be reduced by trimming the top thin electrode 18. This can be accomplished by direct-

ing a laser beam 20 against electrode 18 to vaporize a portion thereof, as shown by Fig. 1J. As the electrode 18 is extremely thin, a very low energy beam can be used. In addition to requiring low power, this has the further advantage that it does not penetrate through the dielectric 14, 16 or cause other damage to the capacitor. The laser 20 can be directed to remove a line across electrode 18, or to provide any desired pattern, as is well known.

As stated above, organo-metallic pastes having platinum or palladium particles can be used for the thin top electrode, but paste with gold atoms has the advantage that the sheet resistance of the electrode is much less than for these other metals. The higher resistance of the electrode reduces the Q of the capacitor, so that the use of gold gives a higher Q than that produced by the use of paste including platinum or palladium.

The materials referred to above which form the organometallic paste, that is Engelhard Bright Gold No. A3725 and No. 6340, are known for use as decorative coatings, but have not been used to provide an extremely thin electrode which can be easily trimmed by use of low energy. We have found that the thin sintered layer of gold particles having a thickness of the order of 1 micron forms an effective electrode and is easily trimmed to adjust the capacitor value.

Although in the process described each paste layer is dried and fired before the next layer is applied, it may be satisfactory in some instances to dry each layer before the next layer is applied, and then fire a plurality of layers at the same time. This has the disadvantage that solvent from the applied paste layer may penetrate the lower dried layer. When the layer is fired before the next paste layer is applied, this action is minimized.

Fig. 2 is an enlarged cross-sectional view of a capacitor constructed in accordance with the invention, generally similar to Fig. 1J. The thickness of the substrate 10 is not critical, and will be determined by the particular application. As previously stated, this may be in the range from 10 to 25 mils. The first platinum-silver electrode 12 has a reference thickness X, which can be in the range from 12 to 15 microns (0.5 mil). The dielectric 14, 16 can be about twice this thickness, 2X or somewhat more. As has been stated, a thickness in the range from 30 to 40 microns has been found to be suitable. The top gold electrode 18 is much thinner and has a thickness of only one tenth X or about 1 micron.

Figs. 2, 3 and 4 show a chip capacitor which can be constructed by the process which has been described. In this case, the capacitor is built up on a chip carrier 22, which is generally equivalent to the substrate shown in Figs. 1 and 2. This chip carrier 22 can also be formed of alumina, and can have a thickness of from 15 to 25 mils. The first electrode 24 is formed on the chip carrier 22, as by applying a platinum-silver conductive paste. This is screened in a pattern as shown by Fig. 3 and dried and fired to form a layer having a thickness of about 13 microns (0.5 mil). The dielectric

material 26 is then applied on the electrode 24 to cover the remainder of the chip carrier 22 covered by electrode 24. This can be applied in two layers, as described to form a thickness of about 30 microns. Then the gold top electrode 28 is applied on the dielectric 26, in the manner previously described. This can be an organo-metallic paste including molecules containing gold atomic particles. The paste can be screened in a desired pattern with a thickness of about 25 microns. When this is dried and fired, a conductive layer of gold particles is formed having a thickness of the order of 1 micron, as had been described.

As shown by Fig. 4, the bottom surface of the carrier 22 has conductive coatings 30 and 32 thereon which facilitate connecting the chip capacitor to a printed circuit board, or the like. The coating 30 is connected by a plating 34 in a recess in the carrier 22 to the bottom electrode 24, and the coating 32 is connected by a plating 36 in a recess in the carrier 22, and a continuing recess in the dielectric 26, to the top electrode 28. Thus, the coatings 30 and 32 form terminals for the chip capacitor of Fig. 3 for connecting the same in a circuit.

It is noted that the bottom electrode 24 does not extend to the conductive plating 36 (Fig. 4) and that the top electrode 28 does not engage the plating 34. Additional conductors plated through openings in the chip carrier 22 can be provided for connecting terminal pad 30 to electrode 24, if desired. The bottom of the carrier 22 (Fig. 4) can also have bands 38 thereacross to designate the value of the chip capacitor, as is known.

The value of the capacitor of Fig. 3 can be adjusted by trimming the thin top electrode 28, as has been described. As the electrode 28 is formed by small sintered conductive atoms or particles which engage each other, a low energy laser beam can be used for this purpose. Such a low energy beam will vaporize the very thin layer without penetrating through the dielectric 26, as generally illustrated by Fig. 2. The capacitor is not shorted or otherwise damaged by this trimming operation. The capacitor value can be monitored during trimming so that a capacitor having a highly accurate value can be produced.

By use of the process described, a thick film capacitor is produced, the value of which can be adjusted so that a highly accurate capacitor is provided at low cost. The thick film process is much less expensive than known thin film processes, and as the top electrode is very thin it can be trimmed by use of a low energy laser beam which does not penetrate the dielectric layer, or otherwise damage the capacitor.

Claims

1. A process for making a thick film capacitor including the steps of:

screening a first layer (12) of conductive paste onto a substrate (10) to form a first capacitor electrode,

drying the first conductive paste layer (12),

screening a second layer (14) of dielectric paste over the first conductive layer (12) to form a capacitor dielectric,

drying the second dielectric paste layer (14),

screening a third paste layer (18) over the second dielectric layer (14) to form a second capacitor electrode,

drying the third paste layer (18),

firing the first, second and third layers, and

trimming the third layer by using a laser beam to adjust the size of the electrode formed thereby and therefore the value of the capacitor,

characterised in that said third layer is screened using an organo-metallic paste having molecules providing conductive particles and in that the firing is continued until the third organo-metallic paste layer (18) is reduced to form a layer of conductive particles, said layer having a maximum thickness of 2 microns.

2. The process of claim 1 including the further steps of firing the first layer before the second layer is applied, and firing the second layer before the third layer is applied.

3. The process of either claim 1 or claim 2 wherein an additional layer (16) of dielectric paste is applied over the second dielectric layer (14) prior to the application of the third layer (18) of organo-metallic paste.

4. The process of any preceding claim wherein the organo-metallic layer (18) includes molecules containing gold atoms.

5. The process of any preceding claim wherein the third layer (18) is reduced to a thickness of the order of 1 micron.

6. The process of any preceding claim wherein the third layer (18) is trimmed by use of a low energy laser beam.

7. An adjustable thick film capacitor suitable for trimming by means of a laser beam, the capacitor comprising

a substrate (10) having thereon a first conductive layer (12) formed by a conductive paste which has been dried and fired to form a first electrode, said first conductive layer (12) having thereon a dielectric layer (14) which has been formed by a dielectric paste which has been dried and fired, and said dielectric layer (14) having thereon a second conductive layer (18) which forms a second adjustable conductive electrode, characterised in that said second conductive layer (18) is formed by an organo-metallic paste which has been dried and fired, said organo-metallic paste having conductive particles therein which have been sintered to form a layer less than 2 microns thick formed by particles which engage each other.

8. The capacitor of claim 7 wherein said organo-metallic paste includes molecules having gold atoms.

9. The capacitor of claim 8 wherein said second conductive layer (18) is formed by said gold atoms and has a thickness of the order of 1 micron and is adapted to be trimmed by use of a low energy beam.

10. The capacitor of claim 9 wherein said sub-

material 26 is then applied on the electrode 24 to cover the remainder of the chip carrier 22 uncovered by electrode 24. This can be applied in two layers, as described to form a thickness of about 30 microns. Then the gold top electrode 28 is applied on the dielectric 26, in the manner previously described. This can be an organo-metallic paste including molecules containing gold atomic particles. The paste can be screened in a desired pattern with a thickness of about 25 microns. When this is dried and fired, a conductive layer of gold particles is formed having a thickness of the order of 1 micron, as had been described.

As shown by Fig. 4, the bottom surface of the carrier 22 has conductive coatings 30 and 32 thereon which facilitate connecting the chip capacitor to a printed circuit board, or the like. The coating 30 is connected by a plating 34 in a recess in the carrier 22 to the bottom electrode 24, and the coating 32 is connected by a plating 36 in a recess in the carrier 22, and a continuing recess in the dielectric 26, to the top electrode 28. Thus, the coatings 30 and 32 form terminals for the chip capacitor of Fig. 3 for connecting the same in a circuit.

It is noted that the bottom electrode 24 does not extend to the conductive plating 36 (Fig. 4) and that the top electrode 28 does not engage the plating 34. Additional conductors plated through openings in the chip carrier 22 can be provided for connecting terminal pad 30 to electrode 24, if desired. The bottom of the carrier 22 (Fig. 4) can also have bands 38 thereacross to designate the value of the chip capacitor, as is known.

The value of the capacitor of Fig. 3 can be adjusted by trimming the thin top electrode 28, as has been described. As the electrode 28 is formed by small sintered conductive atoms or particles which engage each other, a low energy laser beam can be used for this purpose. Such a low energy beam will vaporize the very thin layer without penetrating through the dielectric 26, as generally illustrated by Fig. 2. The capacitor is not shorted or otherwise damaged by this trimming operation. The capacitor value can be monitored during trimming so that a capacitor having a highly accurate value can be produced.

By use of the process described, a thick film capacitor is produced, the value of which can be adjusted so that a highly accurate capacitor is provided at low cost. The thick film process is much less expensive than known thin film processes, and as the top electrode is very thin it can be trimmed by use of a low energy laser beam which does not penetrate the dielectric layer, or otherwise damage the capacitor.

Claims

1. A process for making a thick film capacitor including the steps of:

screening a first layer (12) of conductive paste onto a substrate (10) to form a first capacitor electrode,

drying the first conductive paste layer (12),

screening a second layer (14) of dielectric paste over the first conductive layer (12) to form a capacitor dielectric,

drying the second dielectric paste layer (14),

screening a third paste layer (18) over the second dielectric layer (14) to form a second capacitor electrode,

drying the third paste layer (18),

firing the first, second and third layers, and trimming the third layer by using a laser beam to adjust the size of the electrode formed thereby and therefore the value of the capacitor,

characterised in that said third layer is screened using an organo-metallic paste having molecules providing conductive particles and in that the firing is continued until the third organo-metallic paste layer (18) is reduced to form a layer of conductive particles, said layer having a maximum thickness of 2 microns.

2. The process of claim 1 including the further steps of firing the first layer before the second layer is applied, and firing the second layer before the third layer is applied.

3. The process of either claim 1 or claim 2 wherein an additional layer (16) of dielectric paste is applied over the second dielectric layer (14) prior to the application of the third layer (18) of organo-metallic paste.

4. The process of any preceding claim wherein the organo-metallic layer (18) includes molecules containing gold atoms.

5. The process of any preceding claim wherein the third layer (18) is reduced to a thickness of the order of 1 micron.

6. The process of any preceding claim wherein the third layer (18) is trimmed by use of a low energy laser beam.

7. An adjustable thick film capacitor suitable for trimming by means of a laser beam, the capacitor comprising

a substrate (10) having thereon a first conductive layer (12) formed by a conductive paste which has been dried and fired to form a first electrode, said first conductive layer (12) having thereon a dielectric layer (14) which has been formed by a dielectric paste which has been dried and fired, and said dielectric layer (14) having thereon a second conductive layer (18) which forms a second adjustable conductive electrode, characterised in that said second conductive layer (18) is formed by an organo-metallic paste which has been dried and fired, said organo-metallic paste having conductive particles therein which have been sintered to form a layer less than 2 microns thick formed by particles which engage each other.

8. The capacitor of claim 7 wherein said organo-metallic paste includes molecules having gold atoms.

9. The capacitor of claim 8 wherein said second conductive layer (18) is formed by said gold atoms and has a thickness of the order of 1 micron and is adapted to be trimmed by use of a low energy beam.

10. The capacitor of claim 9 wherein said sub-



strate (10) is a flat capacitor chip carrier and said first conductive layer (12) is on one side of said carrier, and further including terminal conductors on the opposite side of said carrier and conductors extending through said carrier connecting said terminal conductors to said electrodes.

Patentansprüche

1. Verfahren zur Herstellung eines Dickfilmkondensators mit folgenden Schritten:

Siebdrucken einer ersten Schicht (12) aus leitfähiger Paste auf ein Substrat (10) zur Ausbildung einer ersten Kondensatorelektrode,

Trocknen der ersten Schicht (12) aus leitfähiger Paste,

Siebdrucken einer zweiten Schicht (14) aus dielektrischer Paste über die erste, leitfähige Schicht (12) zur Ausbildung eines Kondensatordielektrikums,

Trocknen der zweiten Schicht (14) aus dielektrischer Paste,

Siebdrucken einer dritten Pastenschicht (18) über die zweite, dielektrische Schicht (14) zur Ausbildung einer zweiten Kondensatorelektrode,

Trocknen der dritten Pastenschicht (18), Brennen der ersten, zweiten und dritten Schichten, und

Trimmen der dritten Schicht unter Verwendung eines Laserstrahls, um die Größe der durch diese gebildeten Elektrode und dadurch die Größe der Kapazität einzustellen,

dadurch gekennzeichnet, daß die dritte Schicht unter Verwendung einer metallorganischen Paste siebgedruckt wird, die Moleküle aufweist, die leitfähige Partikel bilden,

und daß das Brennen solange fortgeführt wird, bis die dritte, metallorganische Pastenschicht (18) reduziert ist, um eine Schicht aus leitfähigen Partikeln auszubilden, wobei diese Schicht eine Maximaldicke von 2 µm aufweist.

2. Verfahren nach Anspruch 1, bei dem die erste Schicht vor der zweiten Schicht gebrannt wird und die zweite Schicht vor der dritten Schicht gebrannt wird.

3. Verfahren nach Anspruch 1 oder 2, bei dem eine zusätzliche Schicht (16) aus dielektrischer Paste über der zweiten, dielektrischen Schicht (14) vor dem Aufbringen der dritten Schicht (18) aus metallorganischer Paste aufgebracht wird.

4. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die metallorganische Schicht (18) Moleküle enthält, die Goldatome enthalten.

5. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die dritte Schicht (18) auf eine Dicke in der Größenordnung von 1 µm reduziert wird.

6. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die dritte Schicht (18) unter Verwendung eines Laserstrahls niedriger Energie getrimmt wird.

7. Einstellbarer Dickfilmkondensator, der zur Trimmung mittels eines Laserstrahls geeignet ist, enthaltend:

Ein Substrat (10), auf dem sich eine erste leit-

fähige Schicht (12) befindet, die von einer leitfähigen Paste gebildet wird, die getrocknet und gebrannt worden ist, um eine erste Elektrode zu bilden, eine dielektrische Schicht (14) auf der ersten, leitfähigen Schicht (12), welche dielektrische Schicht (14) von einer dielektrischen Paste gebildet worden ist, die getrocknet und gebrannt worden ist, eine zweite leitfähige Schicht (18) auf der dielektrischen Schicht (14), welche zweite leitfähige Schicht (18) eine zweite, einstellbare leitfähige Elektrode bildet, dadurch gekennzeichnet, daß die zweite leitfähige Schicht (18) von einer metallorganischen Paste gebildet ist, die getrocknet und gebrannt worden ist, welche metallorganische Paste leitfähige Partikel enthält, die gesintert worden sind, um eine Schicht von weniger als 2 µm Dicke zu bilden, die von Partikeln gebildet sind, die einander berühren.

8. Kondensator nach Anspruch 7, bei dem die metallorganische Paste Moleküle enthält, die Goldatome aufweisen.

9. Kondensator nach Anspruch 8, bei dem die zweite leitfähige Schicht (18) von Goldatomen gebildet ist und eine Dicke in der Größenordnung von 1 µm aufweist und geeignet ist, unter Verwendung eines Strahles niedriger Energie getrimmt zu werden.

10. Kondensator nach Anspruch 9, bei dem das Substrat (10) ein flacher Kondensatorchipträger ist und die erste leitfähige Schicht (12) sich auf einer Seite des genannten Trägers befindet, und weiterhin enthaltend Anschlußleiter auf der gegenüberliegenden Seite des Trägers und Leiter, die sich durch den Träger erstrecken und die Anschlußleiter mit den genannten Elektroden verbinden.

Revendications

1. Procédé de fabrication d'un condensateur à couche épaisse, comprenant les étapes suivantes:

l'application par sérigraphie d'une première couche (12) d'une pâte conductrice sur un substrat (10) afin qu'une première électrode de condensateur soit formée,

le séchage de la première couche (12) d'une pâte conductrice,

l'application par sérigraphie d'une seconde couche (14) d'une pâte diélectrique sur la première couche conductrice (12) afin qu'un diélectrique de condensateur soit formé,

le séchage de la seconde couche (14) d'une pâte diélectrique,

l'application par sérigraphie d'une troisième couche (18) d'une pâte sur la seconde couche diélectrique (14) afin qu'une seconde électrode de condensateur soit formée,

le séchage de la troisième couche (18) de pâte, la cuisson de la première, de la seconde et de la troisième couche, et

l'ajustement de la troisième couche à l'aide d'un faisceau laser afin que la taille de l'électrode ainsi formée et en conséquence la valeur du condensateur soient réglées,



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caractérisé en ce que la troisième couche est formée par sérigraphie à l'aide d'une pâte organométallique ayant des molécules formant des particules conductrices, et en ce que la cuisson est poursuivie jusqu'à ce que la troisième couche (18) d'une pâte organométallique soit réduite et forme une couche de particules conductrices, cette couche ayant une épaisseur maximale de 2 microns.

2. Procédé selon la revendication 1, comprenant les étapes supplémentaires de cuisson de la première couche avant application de la seconde couche, et de cuisson de la seconde couche avant application de la troisième couche.

3. Procédé selon l'une des revendications 1 et 2, dans lequel une couche supplémentaire (16) d'une pâte diélectrique est appliquée sur la seconde couche diélectrique (14) avant application de la troisième couche (18) d'une pâte organométallique.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel la couche organométallique (18) contient des molécules comprenant des atomes d'or.

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel la troisième couche (18) est réduite à une épaisseur de l'ordre de 1 micron.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel la troisième couche (18) est ajustée à l'aide d'un faisceau laser de faible énergie.

7. Condensateur réglable à couche mince pouvant être ajusté à l'aide d'un faisceau laser, le condensateur comprenant

un substrat (10) portant une première couche conductrice (12) formée par une pâte conductrice qui a été séchée et cuite afin qu'elle forme une première électrode, la première couche conductrice (12) portant une couche diélectrique (14) qui a été formée par une pâte diélectrique qui a été séchée et cuite, et la couche diélectrique (14) ayant une seconde couche conductrice (18) qui forme une seconde électrode conductrice réglable, caractérisé en ce que la seconde couche conductrice (18) est formée par une pâte organométallique qui a été séchée et cuite, la pâte organométallique contenant des particules conductrices qui ont été frittées afin qu'elles forment une couche d'épaisseur inférieure à 2 microns, constituée de particules qui sont en contact mutuel.

8. Condensateur selon la revendication 7, dans lequel la pâte organométallique contient des molécules ayant des atomes d'or.

9. Condensateur selon la revendication 8, dans lequel la seconde couche conductrice (18) est formée par les atomes d'or et a une épaisseur de l'ordre de 1 micron et est destinée à être ajustée à l'aide d'un faisceau de faible énergie.

10. Condensateur selon la revendication 9 dans lequel le substrat (10) est un support plat de condensateur élémentaire et la première couche conductrice (12) est placée sur une face de ce support, le condensateur comprenant en outre des conducteurs formant des bornes sur l'autre face du support et des conducteurs disposés à travers le support et reliant les conducteurs des bornes aux électrodes.

