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(54) Coins and methods for producing coins

(57) A coin comprises a substrate 20 having one or more coating layers 22,24 of a material or materials different from the substrate 20: a pattern or design is formed using a high power laser to cause localised melting and mixing or alloying of the coating layer and substrate, or of the superposed coating layers. This provides an observable or measurable effect, for establishing the authenticity of the coin.

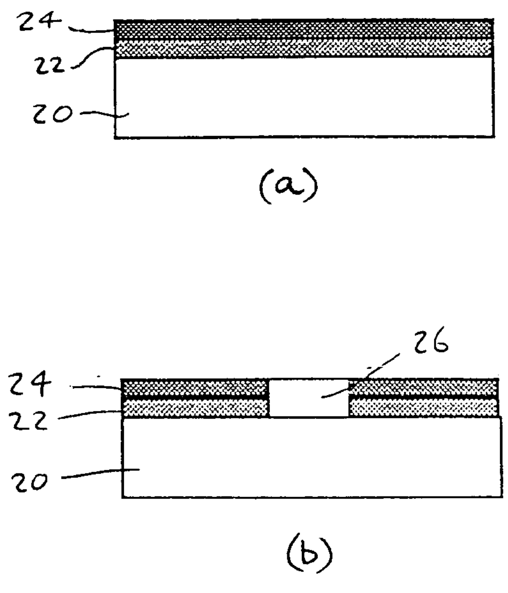

Figure 2

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Description

The present invention relates to coins and more particularly to the formation of designs or patterns in the surfaces of coins.

In recent years, coinage across the world has been increasingly manufactured by electroplating a surface layer over a core or substrate material, usually of mild steel. Steel coins plated with nickel, copper, brass or bronze are now used in numerous countries world-wide. In a smaller number of cases, nickel or zinc has been chosen as the core material. In addition, certain coins have been manufactured from coated ("clad") strip, with steel, nickel, cupro-nickel or copper being used as in the inner layer.

Hitherto, there has been a limitation in the issue of coins of high value since features that could be added for authentication at a cost commensurate with the value of the coin have been capable of forgery.

It is one object of the present invention to provide a process for providing coins with authentication features that cannot easily be reproduced.

It is another object of the present invention to provide a process for providing coins with machine-readable features that can be used for authentication in coin-operated machinery or in machine-operated coin authentication systems.

According to a first aspect of the present invention, there is provided a process for producing a design or pattern in the surface of coins, comprising the steps of pre-coating a substrate of a first material with one or more coating layers which differ from the substrate material, and applying a high power laser beam to define the required design or pattern over the coated surface of the substrate such as to produce localised melting of the coating material and the substrate material (in the case that there is only one coating layer), or localised melting of the coating materials (in the case that there is more than one coating layer applied to the substrate), the localised melting of the materials in the required design or pattern under the action of the laser beam being such that mixing of the materials takes place substantially only in these localised regions so as to produce a measurable or observable difference in optical, electrical or magnetic properties between transformed and untransformed regions.

The transformation achieved as a result of the localised melting can involve full or partial alloying of metal materials or other changes in the structures of the materials which result in said measurable or observable differences in optical, electrical or magnetic properties between the transformed and untransformed regions.

Preferably there are two or more different coating layers applied to the substrate: in this case, no melting of the substrate material need be involved.

The pre-coating step can be carried out by any suitable process, including electro deposition, physical vapour deposition, chemical vapour deposition, roll bonding, or other suitable conventional coating techniques or combination of techniques.

The substrate can be a metal, such as steel, or an alloy, or, in the case of multiple coating layers, any other suitable carrier material.

The coating layers are preferably different elemental metals or metal alloys but could also be other materials such as ceramic or glasses or superconducting or semi-conducting materials.

The laser beam can be moved relative to the substrate material or vice versa, whichever is more convenient, to achieve the required pattern or design. Alternatively, or in addition, the pattern or design can be achieved by the use of one or more masks placed over the target material or disposed directly in the optical system of the laser.

In a preferred embodiment, the observable difference between the transformed and untransformed regions takes the form of a visible distinction in colour between these regions.

The process in accordance with this invention can produce differences of other physical properties between the patterned material and the surrounding material such as optical, electrical or magnetic properties which act as a barrier to forgery and which permit automatic recognition in vending machines or bank counting and sorting machines, particularly as a means of establishing the authenticity of the coin. For example, this could include the production of optical features such as a difference in the specularity of patterned regions on the surface of the coin which could be used by the public as a readily visible mark of the authenticity of the coin.

Another example consists in the formation of a bar code as a means of recognition. This can be achieved, for example, by selection of the types of materials in the predeposited layers in order that the required difference in properties with untransformed material is displayed in the transformed regions produced by the laser, as described further hereinafter.

In accordance with a second aspect of the invention, there is provided a process for producing a design or pattern in the surface of coins, comprising the steps of pre-coating a substrate of a first metallic material with one or more metallic coating layers which differ from the substrate material, and applying a high power laser beam to define the required design or pattern over the coating surface of the substrate such as to produce localised melting of the coating material and the substrate material (in the case that there is only one coating layer), or localised melting of the coating materials (in the case that there is more than one coating layer applied to the substrate), the localised melting of the materials in the required design or pattern under the action of the laser beam being such that mixing and alloying of the materials takes place substantially only in these localised regions so as to produce a measurable or observable difference in optical, electrical or magnetic properties between alloyed and unalloyed regions.

The parameters of the laser alloying process are preferably determined for the suitable control of the composition of the resulting alloy layers by pre-selecting the depth of melting and the relative thickness of the coating layers.

For example, with any laser capable of causing surface melting of the coated starting materials (for example, but not exclusively, CO_2, CO, Nd:YAG, Nd:glass lasers;GaAs,A1As,A1GaAs and other solid state diode lasers; liquid dye or ruby lasers, Ti:sapphire lasers - these lasers operating in continuous or pulsed mode or Q:switched mode) and with combinations of predeposited layers of thickness of 0.1-1000 μm and with laser power in the range 10-10,000 W or pulsed energy in the range 0.1-1000 Joules/pulse and laser spot size of 0.1-20 mm and substrate rate of movement beneath the laser beam of 0.1-1000 mm/s, alloyed layers of depth 0.1-1000 μm can be created at specific regions on the surface. In this way the chemical composition of the alloyed layer can be controlled by selection of the laser process parameters and the relative thickness of the pre-coated layers. Control of the above parameters also allows control of the melt depth and the melt width and hence the physical dimensions of the laser alloy pattern produced.

The process of the invention produces patterns in the alloy layers by a control of the degree of absorption of the laser energy during processing as a result of the application of a laser energy absorbent coating on the surface which is applied only to those areas where absorption is required (and hence for alloying to take place). Hence, for example, a dark coloured or other coloured absorbent coating may be applied by any conventional printing process in the pattern or design which is required. Because of the high selectivity of absorption of laser energy between treated and untreated regions, when the laser is scanned across the surface of the material which has been coated with successive layers of constituent alloy material as described above, the pattern is reproduced as a laser alloy printed design in the surface (as a result of alloying taking place only in those regions beneath the absorbent coating layer).

In according with a third aspect of the invention, there is provided a coin comprising a substrate of a first material, the substrate having one or more coating layers of a material or materials which differ from the substrate material, and carrying a design or pattern formed by localised melting of the coating material and the substrate material (in the case that there is only one said coating layer), or by localised melting of said coating materials (in the case that there is more than one coating layer applied to the substrate).

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 illustrates a typical laser arrangement by which the present technique can be performed;

Fig. 2a is a sectional view illustrating a substrate carrying two surface coatings of different metals prior to laser treatment;

Fig. 2b is a sectional view, corresponding to Fig. 2a, showing the condition following laser treatment; and

Fig. 3 (a) to (f) show examples of some possible designs that can be produced in coins using the technique of the present invention.

The apparatus of Fig. 1 includes a laser 10, a mask 12, an angled mirror 14 and an X-Y support table 16 for carrying a sample object 18 to be patterned. The laser beam is indicated at 20 and is arranged to deliver sufficient energy to melt the coating layer(s) on the substrate and promote alloying (or mixing) only in the areas where the design is required. When the resulting alloy is a different colour to the outer layer on the substrate, a visible printed design is thereby produced.

This apparatus is in itself conventional and has been used already for laser ablation and laser engraving techniques. Indeed, several processes are known at the present time for the production of alloys on the surface of metallic and other material, using the action of a laser on a pre-coated layer of another material on a substrate which is mixed with the substrate on melting to form an alloy, these processes being known generically as laser surface alloying. However, none of these processes has the object of creating alloying in restricted regions of the surface in order to produce a design or pattern resulting from the difference in colour, optical, magnetic, electrical, superconducting or semiconducting properties of the design compared with the unalloyed surrounding material, for the production of patterning or recognition features in coins.

It should be noted that the process performed by the apparatus of Fig. 1 can equally well be operated without a mask 12, producing a pattern by moving the X-Y table beneath the laser beam 20.

In the example shown in Fig. 2, a steel substrate 20 is first provided with thin coatings of nickel 22 and copper 24 by any of the techniques described hereinbefore and within the thickness ranges specified. After laser operation, a localised stripe 26 is formed which consists of a Cu-Ni alloy: this has a different colour to the surrounding copper and is therefore clearly visible to the naked eye as a means of identification for example, for authentication purposes.

The process of Fig. 2 can equally well work with a single metal layer on the substrate, in which case the material of the single metal layer is alloyed with material from the adjacent portion of the substrate to produce the required alloying. It will be noted that this is distinguished from known laser engraving techniques since the latter do not seek to achieve melting and alloying, but instead achieve total removal of the engraved material. By use of the present invention, localised melting and alloying of the superposed materials creates a different type of structure in a finely restricted zone enabling the latter zone to be exploited as an ornamentation or as a security device, or as both, as described hereinbefore.

Ornamental effects rely on the visible contrast in the colours of metals and alloys. Historically, there have been three basic colours used for metallic coinage - red, yellow and white. If it is required to maintain use of those colours, the present technique could be used to provide alloys from an appropriate combination of materials from the following categories:

RED	YELLOW	WHITE
For example: Copper	For example: Gold Brass (Cu-Zn) Bronze (Cu-Sn) Aluminium Bronze (Cu-A1)	For example: Silver Cupro-Nickel Nickel Nickel Silver Silver,

The coloured trace generated by the laser might be a simple line or geometric pattern. Alternatively, as an ornamental feature, it could be used to highlight certain features in the coin design such as the effigy, the date or the edge beading.

From the point of view of security, the presence of a localised visible trace generated in the surface of the coin by the present invention serves to enhance the intrinsic security of the coin. It will be difficult for a counterfeiter to attempt to reproduce the feature without recourse to a similar very expensive laser device. Furthermore, it would be no easy matter to impart the trace in a finished coin. In the application of the present process, the laser processing is carried out before the coin has been struck, i.e. on a flat blank.

The presence of a detectable trace in the surface can serve to authenticate a coin in much the same way as a watermark or metal thread is used in a banknote. However, the surface trace in the coin can also be designed to be detected by an automatic coin validator in vending machines, bank counting and sorting machines and the like.

A machine-readable feature need not require that the trace be of contrasting colour. For example if cupro-nickel (the silver-coloured alloy presently used for such denominations such as the British 50p or the German 1 DM) is plated with a layer of nickel, the laser can be used to generate a localised cupro-nickel alloy at the surface. This trace will not contrast in colour but, when the coin is carefully examined, the trace is just visible by virtue of its slightly different hue. More importantly, however, the physical properties of the coin are disrupted locally so that it becomes possible to detect this in a suitably adapted coin validator.

Most coin validators today are electronic devices in which the coin passes a series of coils operating at various frequencies. The presence of the coin alters the resonant frequency of these coils and the amplitude of the signal.

The shift in one, or other, or both of these parameters serves to characterise the coin being tested. The highest frequency coils are used to detect the surface properties of the coin, and the lower frequencies for the interior. These devices are thus particularly well suited to the new generation of plated coins, because in principle both of the metallic components can be distinguished in this way.

Figure 3 show diagrammatically examples of possible designs that can be produced in coins using the method of the present invention. Figure 3(a) shows a single stripe 30. Figure 3(b) shows a double stripe 31,32. Figure 3(c) shows a barcode 33 (which may be either a magnetic or optical barcode). Figure 3(d) shows a pattern 34 in the form of the date (in this case the calendar year of production of the coin). Figure 3(e) shows a design 35 in the form of a head. Figure 3(f) shows a pattern 36.

Claims

1. A coin comprising a substrate of a first material, the substrate having one or more coating layers of a material or materials which differ from the substrate material, and carrying a design or pattern formed by localised melting of the coating material and the substrate material (in the case that there is only one said coating layer), or by localised melting of said coating materials (in the case that there is more than one coating layer applied to the substrate).

2. A coin as claimed in claim 1, wherein said substrate and coating layer or layers are metallic whereby said design or pattern is formed by one or more alloyed regions of the materials.

3. A coin as claimed in claim 1 or 2, wherein said design or pattern formed by the localised melted region or regions comprises a stripe or stripes.

4. A coin as claimed in claim 3, wherein said stripes form a magnetic or optical barcode.

5. A coin as claimed in claim 1 or 2, wherein said design or pattern formed by the localised melted region or regions comprises a geometric pattern and/or an ornamental pattern.

6. A process for producing a design or pattern in the surface of coins, comprising the steps of pre-coating a substrate of a first material with one or more coating layers which differ from the substrate material, and applying a high power laser beam to define the required design or pattern over the coated surface of the substrate such as to produce localised melting of the coating material and the substrate material (in the case that there is only one coating layer), or localised melting of the coating materials (in the case that there is more than one coating layer applied to the substrate), the localised melting of the materials in the required design or pattern under the action of the laser beam being such that mixing of the materials takes place substantially only in these localised regions so as to produce a measurable or observable difference in optical, electrical or magnetic properties between transformed and untransformed regions.

7. A process for producing a design or pattern in the surface of coins, comprising the steps of pre-coating a substrate of a first metallic material with one or more metallic coating layers which differ from the substrate material, and applying a high power laser beam to define the required design or pattern over the coating surface of the substrate such as to produce localised melting of the coating material and the substrate material (in the case that there is only one coating layer), or localised melting of the coating materials (in he case that there is more than one coating layer applied to the substrate), the localised melting of the materials in the required design or pattern under the action of the laser beam being such that mixing and alloying of the materials takes place substantially only in these localised regions so as to produce a measurable or observable difference in optical, electrical or magnetic properties between alloyed and unalloyed regions.

8. A process as claimed in claim 7, wherein the parameters of the alloying process achieved by the application of the laser beam are determined for the suitable control of the composition of the resulting alloy layers by pre-selecting the depth of melting and the relative thickness of the coating layer or layers.

9. A process as claimed in claim 6, wherein there are two or more different coating layers applied to the substrate whereby no melting of the substrate material takes place.

10. A process as claimed in claim 6 or 9, wherein the coating layer or layers is or are metallic.

11. A process as claimed in claim 10, in which the pre-coating step is carried out by electro deposition, physical vapour deposition, chemical vapour deposition, or roll bonding, or a combination of any of the latter techniques.

12. A process as claimed in claim 6, 10 or 11, in which the substrate is made of a metal or metal alloy.

13. A process as claimed in claim 6, 10 or 11, in which the substrate is provided with a plurality of coating layers and wherein the substrate is non-metallic.

14. A process as claimed in claim 13, wherein the substrate is made of a ceramic, glass, superconducting or semi-conducting material.

15. A process as claimed in any of claims 6 to 14, wherein the required pattern is defined over the coated surface of the substrate by moving the laser beam relative to the substrate material.

16. A process as claimed in any of claims 6 to 14, wherein the required pattern is defined over the coated surface of the substrate by moving the substrate material relative to the laser beam.

17. A process as claimed in any of claims 6 to 14, wherein the required pattern is defined over the coated surface of the substrate by positioning a mask in the path of the laser beam.

18. A process as claimed in any of claims 6 to 14, wherein the required pattern is defined over the coated surface of

the substrate by applying an additional laser energy absorbent coating only on those area whose absorption is required.

19. A process as claimed in any of claims 6 to 18, wherein the substrate material and/or the coating layer material or materials are selected so that said observable difference between the transformed and untransformed regions takes the form of a visible distinction in colour between these regions.

20. A process as claimed in any of claims 6 to 19, wherein said design or pattern is arranged to be in the form of a barcode.

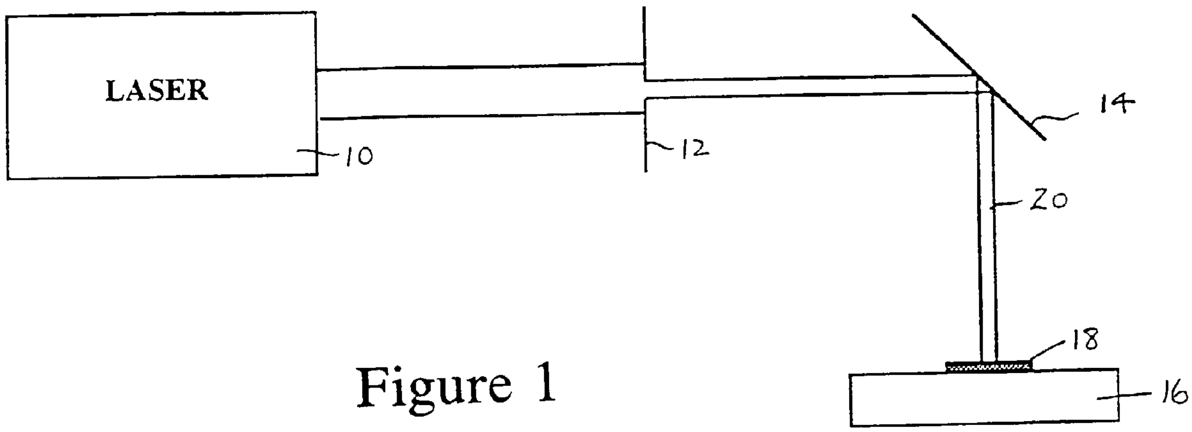

Figure 1

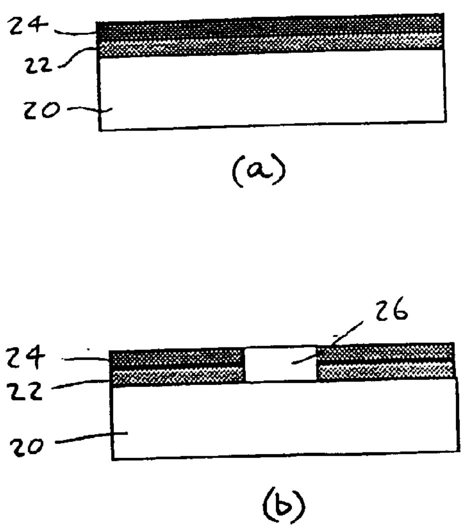

Figure 2

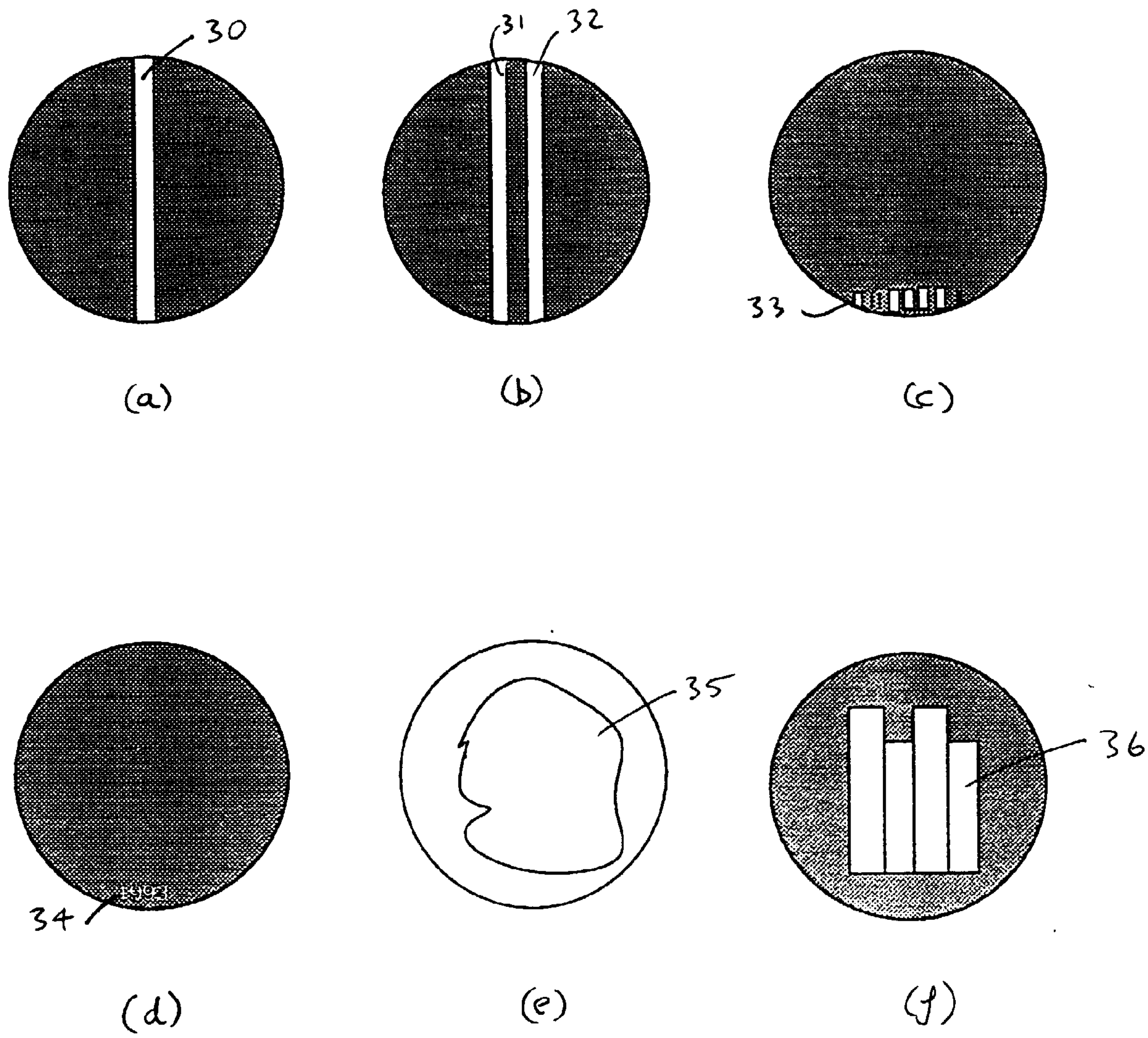

Figure 3