WHAT IS CLAIMED IS:

1. A method comprising:

selecting a metal and a corresponding etchant such that said etchant selectively etches said metal over nickel;

sputtering said metal onto a surface of a template having nano-structures to form a sacrificial layer covering said nano-structures;

electroplating nickel onto said sacrificial layer to form a nickel mold, leaving a portion of said sacrificial layer exposed; and

contacting said sacrificial layer with said etchant through said exposed portion of said sacrificial layer to etch away said sacrificial layer until said nickel mold is separated from said template, said nickel mold having a front side having nano-structures and a back side opposite said front side; and

replicating said nickel mold by electroplating to produce a replicate mold larger than said nickel mold and having nano-structures that match said nano-structures on said template, wherein said replicating comprises:

placing said nickel mold in an opening of a metal base sized to receive said nickel mold, wherein a conductive film is sandwiched between said metal base and said back side of said nickel mold; and

electroplating nickel onto said front side of said nickel mold and said metal base to form said replicate mold.

2. The method of claim 1, wherein said metal is copper.

3. The method of claim 2, wherein said etchant is a mixture of water, ammonia and hydrogen peroxide.

4. The method of claim 1, wherein said nano-structures have a feature size of about 10 nm to about 100 nm.

5. The method of claim 1, wherein said nano-structures have an aspect ratio of 3 or higher.

6. The method of claim 1, wherein said Ni mold has an over size of about 5 cm to about 10 cm, and said replicate mold has an overall size of about 10 to about 50 cm.

7. The method of claim 1, wherein said sacrificial layer has a thickness of about 10 nm to about 100 nm.

8. The method of claim 1, comprising limiting exposure of said sacrificial layer to oxygen to prevent oxidation of said metal in said sacrificial layer before etching said sacrificial layer.

9. The method of claim 8, wherein said limiting exposure of said sacrificial layer to oxygen comprises immersing said sacrificial layer in an inert gas or covering said sacrificial layer with a removable shield layer.

10. The method of claim 1, wherein said template comprises a polymeric resist formed on a substrate.

11. The method of claim 1, wherein said metal base has a size of about 10 to about 50 cm.

12. The method of claim 1, comprising passivating a surface of said Ni mold and said metal base before said replicating.

13. The method of claim 1, further comprising depositing a conductive material in a groove formed between said nickel mold and said metal base to fill said groove.

14. The method of claim 13, wherein said conductive material comprises an epoxy.

15. The method of claim 1, wherein said conductive film is a magnetic foil.

16. The method of claim 1, further comprising applying a conductive tape on said metal base and said nickel mold to provide electric contact therebetween.

17. The method of claim 1, further comprising separating said replicate mold from said metal base.

WHAT IS CLAIMED IS:

1. A method comprising:

selecting a metal and a corresponding etchant such that said etchant selectively etches said metal over nickel;

sputtering said metal onto a surface of a template having nano-structures to form a sacrificial layer covering said nano-structures;

electroplating nickel onto said sacrificial layer to form a nickel mold, leaving a portion of said sacrificial layer exposed; and

contacting said sacrificial layer with said etchant through said exposed portion of said sacrificial layer to etch away said sacrificial layer until said nickel mold is separated from said template, said nickel mold having a front side having nano-structures and a back side opposite said front side; and

replicating said nickel mold by electroplating to produce a replicate mold larger than said nickel mold and having nano-structures that match said nano-structures on said template, wherein said replicating comprises:

placing said nickel mold in an opening of a metal base sized to receive said nickel mold, wherein a conductive film is sandwiched between said metal base and said back side of said nickel mold; and

electroplating nickel onto said front side of said nickel mold and said metal base to form said replicate mold.

2. The method of claim 1, wherein said metal is copper.

3. The method of claim 2, wherein said etchant is a mixture of water, ammonia and hydrogen peroxide.

4. The method of claim 1, wherein said nano-structures have a feature size of about 10 nm to about 100 nm.

5. The method of claim 1, wherein said nano-structures have an aspect ratio of 3 or higher.

6. The method of claim 1, wherein said Ni mold has an over size of about 5 cm to about 10 cm, and said replicate mold has an overall size of about 10 to about 50 cm.

7. The method of claim 1, wherein said sacrificial layer has a thickness of about 10 nm to about 100 nm.

8. The method of claim 1, comprising limiting exposure of said sacrificial layer to oxygen to prevent oxidation of said metal in said sacrificial layer before etching said sacrificial layer.

9. The method of claim 8, wherein said limiting exposure of said sacrificial layer to oxygen comprises immersing said sacrificial layer in an inert gas or covering said sacrificial layer with a removable shield layer.

10. The method of claim 1, wherein said template comprises a polymeric resist formed on a substrate.

11. The method of claim 1, wherein said ~~replicating comprises integrating said Ni mold with a~~ metal base has a size of about 10 to about 50 cm~~by electroplating~~.

12. The method of claim ~~1~~1, comprising passivating a surface of said Ni mold and said metal base before said replicating.

~~13. A method comprising:~~

~~selecting an etchant such that said etchant selectively etches copper over nickel;~~

~~sputtering copper onto a surface of a template having nano-structures to form a sacrificial layer covering said nano-structures;~~

~~electroplating nickel onto said sacrificial layer to form a nickel mold, leaving a portion of said sacrificial layer exposed; and~~

~~contacting said sacrificial layer with said etchant through said exposed portion of said sacrificial layer to etch away said sacrificial layer until said nickel mold is separated from said template.~~

~~14. The method of claim 13, wherein said etchant is a mixture of water, ammonia and hydrogen peroxide.~~

~~15. The method of claim 13, wherein said nano-structures have a feature size of about 10 nm to about 100 nm.~~

~~16. The method of claim 13, wherein said nano-structures have an overall area size of about 5 cm to about 10 cm.~~

~~17. The method of claim 13, wherein said nano-structures have an aspect ratio of 3 or higher.~~

~~18. The method of claim 13, wherein said sacrificial layer has a thickness of about 10 nm to about 100 nm.~~

~~19. The method of claim 13, comprising limiting exposure of said sacrificial layer to oxygen to prevent oxidation of copper in said sacrificial layer before etching said sacrificial layer.~~

~~20. The method of claim 19, wherein said limiting exposure of said sacrificial layer to oxygen comprises immersing said sacrificial layer in an inert gas or covering said sacrificial layer with a removable shield layer.~~

13. The method of claim 1, further comprising depositing a conductive material in a groove formed between said nickel mold and said metal base to fill said groove.

14. The method of claim 13, wherein said conductive material comprises an epoxy.

15. The method of claim 1, wherein said conductive film is a magnetic foil.

16. The method of claim 1, further comprising applying a conductive tape on said metal base and said nickel mold to provide electric contact therebetween.

17. The method of claim 1, further comprising separating said replicate mold from said metal base.

SUMMARY

[0004] In accordance with an aspect of the present invention, there is provided a method comprising selecting a metal and a corresponding etchant such that the etchant selectively etches the metal over nickel; sputtering the metal onto a surface of a template having nano-structures to form a sacrificial layer covering the nano-structures; electroplating nickel onto the sacrificial layer to form a nickel mold, leaving a portion of the sacrificial layer exposed; and contacting the sacrificial layer with the etchant through the exposed portion of the sacrificial layer to etch away the sacrificial layer until the nickel mold is separated from the template. The nickel mold has a front side having nano-structures and a back side opposite the front side. Subsequently, the nickel mold may be replicated or scaled-up by electroplating to produce a replicate mold larger than the nickel mold and having nano-structures that match the nano-structures on the template. The replication comprises placing the nickel mold in an opening of a metal base sized to receive the nickel mold, wherein a conductive film is sandwiched between the metal base and the back side of the nickel mold; and electroplating nickel onto the front side of the nickel mold and the metal base to form the replicate mold.

[0005] The metal for the sacrificial layer may be copper. The etchant may be a mixture of water, ammonia and hydrogen peroxide. The sacrificial layer may have a thickness of about 10 nm to about 100 nm, such as about 50 nm. The nano-structures may have a feature size from about 10 nm to about 100 nm. Exposure of the sacrificial layer to oxygen before etching the sacrificial layer may be limited to prevent oxidation of the metal in the sacrificial layer, such as by immersing the sacrificial layer in an inert gas or covering the sacrificial layer with a removable shield layer. The template may comprise a polymeric resist formed on a substrate. The Ni mold and the metal base may be integrated by electroplating. The metal base may have a size of about 10 to about 50 cm. The method may further comprise passivating a surface of the Ni mold before the replicating. The nano-structures may have an overall area size of about 5 cm to about 10 cm, and the replicated mold may have an overall size of about 20 cm to about 50 cm. A conductive material, such as an epoxy, may be deposited in a groove formed between the nickel mold and the metal base to fill the groove. The conductive film

may be a magnetic foil. A conductive tape may be applied on the metal base and nickel mold to provide electric contact therebetween.

[0006] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

SUMMARY

[0004] In accordance with an aspect of the present invention, there is provided a method comprising selecting a metal and a corresponding etchant such that the etchant selectively etches the metal over nickel; sputtering the metal onto a surface of a template having nano-structures to form a sacrificial layer covering the nano-structures; electroplating nickel onto the sacrificial layer to form a nickel mold, leaving a portion of the sacrificial layer exposed; and contacting the sacrificial layer with the etchant through the exposed portion of the sacrificial layer to etch away the sacrificial layer until the nickel mold is separated from the template. The nickel mold has a front side having nano-structures and a back side opposite the front side. Subsequently, the nickel mold may be replicated or scaled-up by electroplating to produce a replicate mold larger than the nickel mold and having nano-structures that match the nano-structures on the template. The replication comprises placing the nickel mold in an opening of a metal base sized to receive the nickel mold, wherein a conductive film is sandwiched between the metal base and the back side of the nickel mold; and electroplating nickel onto the front side of the nickel mold and the metal base to form the replicate mold.

[0005] The metal for the sacrificial layer may be copper. The etchant may be a mixture of water, ammonia and hydrogen peroxide. The sacrificial layer may have a thickness of about 10 nm to about 100 nm, such as about 50 nm. The nano-structures may have a feature size from about 10 nm to about 100 nm. Exposure of the sacrificial layer to oxygen before etching the sacrificial layer may be limited to prevent oxidation of the metal in the sacrificial layer, such as by immersing the sacrificial layer in an inert gas or covering the sacrificial layer with a removable shield layer. The template may comprise a polymeric resist formed on a substrate. The Ni mold and the metal base may be integrated by electroplating. The metal base may have a size of about 10 to about 50 cm. The method may further comprise passivating a surface of the Ni mold before the replicating. The nano-structures may have an overall area size of about 5 cm to about 10 cm, and the replicated mold may have an overall size of about 20 cm to about 50 cm. A conductive material, such as an epoxy, may be deposited in a groove formed between the nickel mold and the metal base to fill the groove. The conductive film

may be a magnetic foil. A conductive tape may be applied on the metal base and nickel mold to provide electric contact therebetween.

[0006] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.