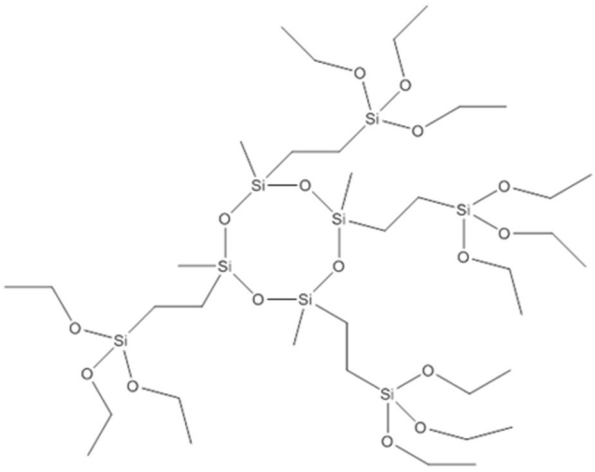
What is claimed is:

Claim 1. An imprinting apparatus, comprising:

a silicon master including a plurality of features positioned at an average pitch of less than 425 nm, each of the plurality of features comprising a depression having an opening with its largest opening dimension being less than 300 nm; and

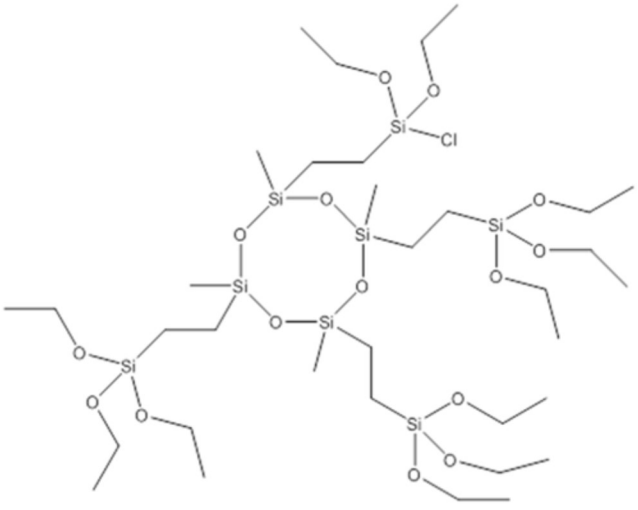
an anti-stick layer coating a surface of the silicon master, the anti-stick layer including a crosslinked silane polymer network formed from a formulation including:

a first silane monomer:



; and

from 0.28 wt% to 1.1 wt%, based on a total amount of silanes present in the formulation, of the second silane monomer:



.

Claim 2. The imprinting apparatus as defined in claim 1, wherein less than 0.15% of a total number of the plurality of features has a membrane defect.

Claim 3. The imprinting apparatus as defined in claim 1, wherein the anti-stick layer coats a wall of each of the depressions without capping the opening or without fully filling the depression.

Claim 4. The imprinting apparatus as defined in claim 1, wherein the largest opening dimension of each of the plurality of features ranges from 170 nm to 290 nm.

Claim 5. The imprinting apparatus as defined in claim 1, wherein the largest opening dimension of each of the plurality of features ranges from 200 nm to 250 nm.

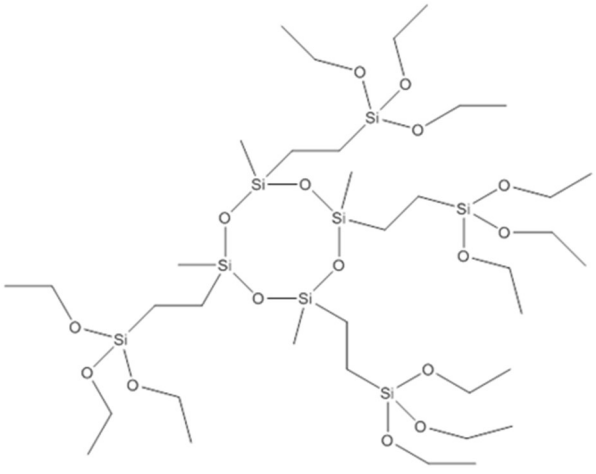
Claim 6. The imprinting apparatus as defined in claim 1, wherein the average pitch ranges from 340 nm to 410 nm.

Claim 7. The imprinting apparatus as defined in claim 1, wherein the average pitch ranges from 350 nm to 400 nm.

Claim 8. A method for making an imprinting apparatus, comprising:

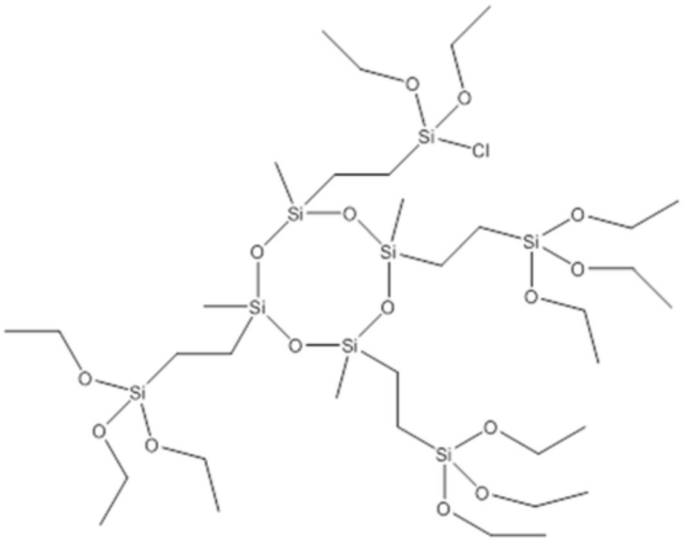
applying a formulation on a surface of a silicon master including a plurality of features positioned at an average pitch of less than 425 nm, each of the plurality of features comprising a depression having an opening with its largest opening dimension being less than 300 nm, the formulation including:

a first silane monomer:



; and

from 0.28 wt% to 1.1 wt% of a second silane monomer:



; and

curing the applied formulation, thereby forming an anti-stick layer.

Claim 9. The method as defined in claim 8, wherein the formulation further includes:

i) a dimer including two bonded units of the first silane monomer;

ii) a trimer including three bonded units of the first silane monomer;

iii) a higher molecular species including more than three bonded units of the first silane monomer;

iv) the first silane monomer having at least one hydrolyzed ethoxy group; or

v) any combination of i), ii), iii), and iv).

Claim 10. The method as defined in claim 8 or 9, wherein curing involves:

an incubation process;

a rinsing process after the incubation process; and

a heating process after the rinsing process

wherein the incubation process and the heating processes are independently performed at a temperature ranging from 20°C to 250°C, for a time ranging from 1 minute to 30 minutes.

Claim 11. The method as defined in claim 8, further comprising generating the formulation by:

diluting a neat silane material including the first and second silane monomers in a first solvent to form a precursor solution;

exposing the precursor solution to an aqueous, basic solution to generate an aqueous phase and an organic phase, wherein the organic phase includes the first solvent;

removing the aqueous phase;

removing the first solvent from the organic phase to obtain a purified silane material; and

diluting the purified silane material in a second solvent

wherein the second solvent is an aprotic solvent that i) solvates the purified silane material and ii) has a boiling point ranging from 50°C to 250°C.

Claim 12. The method as defined in claim 11, wherein the purified silane material is present in the formulation in an amount ranging from 1 wt% to 20 wt%.

Claim 13. The method as defined in claim 8, wherein applying the formulation involves spin coating.

Claim 14. The method as defined in claim 8, wherein one of:

the formulation is solvent free; or

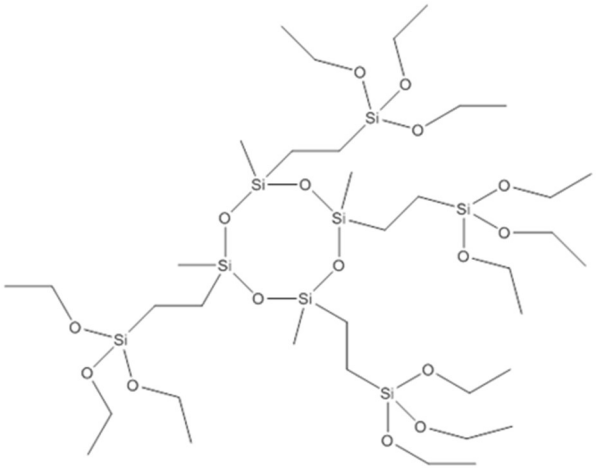
the formulation includes from 1 wt% to 20 wt% of the first silane monomer.

Claim 15. A method for making a working stamp, comprising:

forming an imprinting apparatus by:

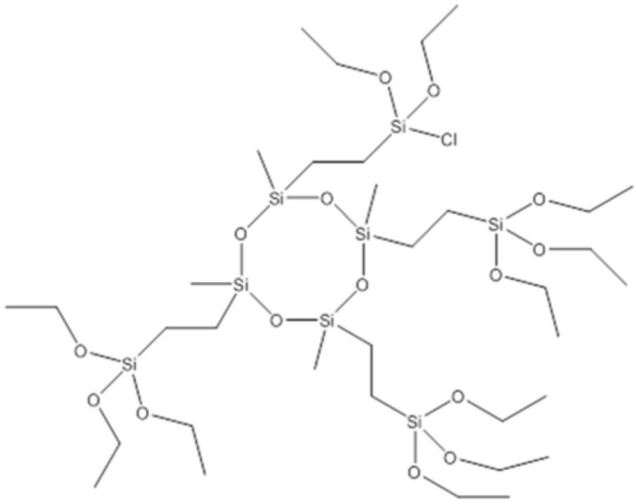
depositing a formulation on a silicon master including a plurality of features positioned at an average pitch of less than 425 nm, each of the plurality of features comprising a depression having an opening with its largest opening dimension of less than 300 nm, and the formulation including:

a first silane monomer:



; and

from 0.28 wt% to 1.1 wt% of a second silane monomer:



; and

curing the formulation, thereby forming an anti-stick layer on the silicon master;

depositing a silicon-based working stamp material on the anti-stick layer of the imprinting apparatus;

curing the silicon-based working stamp material to form the working stamp including a negative replica of the plurality of features; and

releasing the working stamp from the imprinting apparatus.

Claim 16. The method as defined in claim 15, wherein curing the formulation involves:

an incubation process;

a rinsing process after the incubation process; and

a heating process after the rinsing process

wherein the incubation and heating processes are independently performed at a temperature ranging from 20°C to 250°C, for a time ranging from 1 minute to 30 minutes.

Claim 17. The method as defined in claim 15, wherein the silicon-based working stamp material includes a silicon acrylate monomer.