CLAIMS:

1. A method for embedding a deterministic number of dopant atoms in a surface portion of a group IV semiconductor lattice, the method comprising the steps of:

a) forming one or more lithographic sites on the surface portion;

b) dosing, at a temperature below 100 K, the surface portion using a gas with molecules comprising the dopant atoms and hydrogen atoms in a manner such that, a portion of the molecules bonds to the surface portion; and

c) incorporating one or more of the dopant atoms in a respective lithographic site of the one or more lithographic sites by transferring an amount of energy to the dopant atoms;

wherein the number of the dopant atoms incorporated in the respective lithographic site is deterministic and related to a size of the respective lithographic site.

2. The method of claim 1, wherein the surface portion of the group IV semiconductor lattice is a pure crystalline silicon portion or a pure crystalline germanium portion.

3. The method of claim 1 or 2, wherein, during incorporating, the dopant atoms that are not incorporated in the respective lithographic site are released from the surface portion.

4. The method of any one of claims 1 to 3, wherein the molecules in the dosing gas contain phosphine (PH_3) and the dosing process is performed in a manner such that the surface portion is saturated with PH_3 molecules.

5. The method of any one of claims 1 to 4, wherein the dosing process is performed in a manner such that only PH_3 molecules are absorbed and bond with the surface portion at the one or more lithographic sites.

6. The method of any one of claims 1 to 5, wherein the dosing process is performed at a temperature such that dissociation of PH_3 into PH_2 is prevented, wherein the dosing process is performed at a temperature below 40K, or at a temperature between 40K and 100K, or at a temperature of 77K.

7. The method of any one of claims 1 to 5, wherein the dosing process is performed at a temperature such that dissociation of PH_3 into PH_2 occurs spontaneously.

8. The method of any one of claims 1 to 7, wherein the one or more lithographic sites are: 1 by 1 silicon atomic sites, 2 by 1 silicon dimer patches, 3 by 1 silicon dimer patches, 4 by 1 silicon dimer patches, or 5 by 1 silicon dimer patches.

9. The method of any one of claims 1 to 8, wherein the one or more lithographic sites are 3 by 1 silicon dimer patches and the step of incorporating the one or more of the dopant atoms in the respective lithographic site comprises a step of annealing the surface portion in a manner such that a single dopant atoms from a first portion of the bonded molecules are incorporated in the respective lithographic site in the surface portion; and a second portion of the bonded molecules is released from the surface portion, wherein each dimer patch bonds with six PH_2 molecules.

10. The method of claim 9, wherein during the step of annealing, the bonded molecules lose one hydrogen atom, or wherein during the step of annealing, PH_2 molecules bond with an additional hydrogen atom and are released from the surface portion.

11. The method of claim 9 or 10, wherein the step of annealing the surface portion is performed in two phases:

i. a first phase during which the bonded molecules lose one hydrogen atom to form a plurality of PH_2 molecules bonded to the surface portion, wherein the first annealing phase is performed by exposing the surface portion to room temperature;

ii. a second phase during which the bonded molecules lose their two hydrogen atoms to other PH_2 molecules and a single P atom is embedded in a single 3 by 1 silicon dimer patch, wherein the second annealing phase is performed between 200˚C and 400˚C.

12. The method of any one of claims 1 to 11, wherein the step of incorporating the one or more dopant atoms in the respective lithographic site comprises a step of positioning a tip of a scanning tunnelling microscope above one of the molecules and transferring an amount of energy to the dopant atoms through the tip.

13. The method of claim 12, wherein the step of transferring the amount of energy to the dopant atoms comprises applying a current to the dopant atoms and the surface portion of the group IV semiconductor lattice through the tip while the tip is positioned in proximity of the dopant atoms, wherein in order to apply the current through the tip, a feedback control loop of the scanning tunnelling microscope is deactivated and, to increase a magnitude of the current, the tip is controlled to move closer to the dopant atoms.

14. The method of claim 13, further comprising monitoring the magnitude of the applied current for sharp variations triggered by incorporation of the one or more dopant atoms.

15. The method of claim 13 or 14, wherein the magnitude of the current is between 0.1 nA and 10 nA.

16. The method of any one of claims 13 to 15, further comprising applying a voltage between the tip and the surface portion of the group IV semiconductor lattice, the voltage having a magnitude between 2V and 4V.

17. The method of claim 12, wherein the step of transferring the amount of energy to the dopant atoms comprises applying a voltage or current to the dopant atoms and the surface portion of the group IV semiconductor lattice through the tip while a feedback control loop of the scanning tunnelling microscope is active.

18. The method of claim 17, comprising increasing a magnitude of the current and monitoring a distance between the tip and the dopant atoms for sharp variations triggered by incorporation of theft dopant atoms.

19. The method of claim 18, wherein the step of transferring the amount of energy to the dopant atoms comprises applying a voltage pulse with a duration between 0.1 s and 1 s and a magnitude between 2V and 4V, or wherein the step of transferring the amount of energy to the dopant atoms comprises applying a current pulse with a duration between 0.1 s and 1 s and a magnitude between 0.1 nA and 1 nA.

20. The method of any one of claims 17 to 19, wherein a distance between the tip and the dopant atoms is between 0.1 nm and 10 nm.