Claims

1. A seed layer for inducing nucleation to form a layer of material, the seed layer comprising a layer of two-dimensional (2D) monolayer amorphous material having a disordered atomic structure, the disordered atomic structure generating a strained 2D lattice of the layer of 2D monolayer amorphous material and resulting in an atomic rearrangement of the layer of 2D monolayer amorphous material in three-dimensional (3D) space to create localised electronic states to form electric potential wells for bonding adatoms to a surface of the seed layer via van der Waals (vdW) interaction to form the layer of material, wherein the layer of 2D monolayer amorphous material comprises a homogenous 2D monolayer amorphous carbon.

2. The seed layer of claim 1, wherein the seed layer has an optical transparency of more than 98% at a light wavelength between 550 nm to 800 nm.

3. The seed layer of claim 1 or claim 2, wherein the seed layer is thermally stable at a temperature of 700 ˚C.

4. The seed layer of any one of claims 1 to 3, wherein the seed layer further comprises one or more additional layers of 2D monolayer amorphous carbon deposited on the layer of 2D monolayer amorphous material to form a multilayer structure of the seed layer to tune the vdW interaction between the seed layer and the layer of material.

5. A method of forming a seed layer, the seed layer comprising a layer of two-dimensional (2D) monolayer amorphous material having a disordered atomic structure, the disordered atomic structure generating a strained 2D lattice of the layer of 2D monolayer amorphous material and resulting in an atomic rearrangement of the layer of 2D monolayer amorphous material in three-dimensional (3D) space to create localised electronic states to form electric potential wells for bonding adatoms to a surface of the seed layer via van der Waals (vdW) interaction to form a layer of material, wherein the layer of 2D monolayer amorphous material comprises a homogenous 2D monolayer amorphous carbon, the method comprising:

growing the seed layer on a substrate using laser-assisted chemical vapour deposition (LCVD).

6. The method of claim 5, wherein the LCVD is performed at a temperature ranging between 20 ˚C and 400 ˚C.

7. A heterostructure comprising:

a substrate; and

a seed layer formed on the substrate, the seed layer comprising a layer of two-dimensional (2D) monolayer amorphous material having a disordered atomic structure, the disordered atomic structure generating a strained 2D lattice of the layer of 2D monolayer amorphous material and resulting in an atomic rearrangement of the layer of 2D monolayer amorphous material in three-dimensional (3D) space to create localised electronic states to form electric potential wells for bonding adatoms to a surface of the seed layer via van der Waals (vdW) interaction, wherein the layer of 2D monolayer amorphous material comprises a homogenous 2D monolayer amorphous carbon.

8. The heterostructure of claim 7, wherein the substrate comprises one of: a metal, a semiconductor, an insulator, glass, a polymer, silicon, silicon carbide, sapphire, a group III-V substrate, a group II-VI substrate or an oxide.

9. The heterostructure of claim 7 or claim 8, wherein the substrate is a crystalline substrate, the seed layer is adapted to screen effects provided by a crystallinity of the crystalline substrate.

10. The heterostructure of any one of claims 7 to 9, further comprising a layer of material formed on the seed layer, the layer of material being formed by bonding adatoms of the material to the surface of the seed layer via the van der Waals (vdW) interaction.

11. The heterostructure of claim 10, wherein the layer of material comprises one or more layers of a 2D material, the 2D material comprises one of: graphene, borophene, boron nitride, a perovskite, a transition metal dichalcogenide or a black phosphorene.

12. The heterostructure of claim 10, wherein the layer of material comprises one or more layers of a group III-V semiconducting material.

13. The heterostructure of claim 12, wherein the group III-V semiconducting material comprises one of: GaAs, GaN, AlN, InP and InN.

14. The heterostructure of claim 10, wherein the layer of material comprises one or more layers of a group II-VI semiconducting material.

15. The heterostructure of claim 14, wherein the group II-VI semiconducting material comprises one of: CdTe, CdS and ZnS.

16. The heterostructure of claim 10, wherein the layer of material comprises one or more layers of an oxide.

17. The heterostructure of claim 16, wherein the oxide comprises one of: hafnium oxide, aluminium oxide, manganese oxide, perovskite or spinel.

18. The heterostructure of any one of claims 7 to 17, wherein the seed layer comprises one or more additional layers of 2D monolayer amorphous carbon deposited on the layer of 2D monolayer amorphous material to form a multilayer structure of the seed layer to tune the vdW interaction between the seed layer and the layer of material and to remotely modulate an interaction between the substrate and the adatoms for forming the layer of material during growth.

19. A device comprising the heterostructure of any one of claims 7 to 18.

20. A method of forming a layer of material on a substrate, the method comprising:

forming a seed layer on the substrate, the seed layer comprising a layer of two-dimensional (2D) monolayer amorphous material having a disordered atomic structure, the disordered atomic structure generating a strained 2D lattice of the layer of 2D monolayer amorphous material and resulting in an atomic rearrangement of the layer of 2D monolayer amorphous material in three-dimensional (3D) space to create localised electronic states to form electric potential wells for bonding adatoms to a surface of the seed layer via van der Waals (vdW) interaction, wherein the layer of 2D monolayer amorphous material comprises a homogenous 2D monolayer amorphous carbon; and

forming the layer of material on the seed layer by bonding adatoms of the material to the surface of the seed layer via the van der Waals (vdW) interaction.

21. The method of claim 20, further comprising varying the disordered atomic structure of the layer of 2D monolayer amorphous material to modulate a strength of the vdW interaction between the adatoms of the material and the surface of the seed layer.

22. The method of claim 20 or claim 21, further comprising depositing one or more additional layers of 2D monolayer amorphous carbon on the layer of 2D monolayer amorphous material to form a multilayer structure of the seed layer prior to forming the layer of material on the seed layer to tune the vdW interaction between the seed layer and the layer of material and to remotely modulate an interaction between the substrate and the adatoms for forming the layer of material during growth.

23. The method of any one of claims 20 to 22, further comprising:

forming a handling layer on the layer of material; and

detaching the seed layer from the substrate to form a free-standing film comprising the seed layer and the layer of material.

24. The method of any one of claims 21 to 23, wherein forming the seed layer on the substrate comprises growing the seed layer on the substrate using laser-assisted chemical vapour deposition (LCVD).

25. The method of claim 24, wherein the laser-assisted CVD is performed at a temperature between 20 ˚C and 400 ˚C.

26. A method for enhancing van der Waals (vdW) interaction between adatoms and a surface of a seed layer for forming a layer of material on the seed layer, the seed layer comprising a layer of homogenous two-dimensional (2D) monolayer amorphous carbon, the method comprising:

forming a disordered atomic structure in the seed layer, the disordered atomic structure of the seed layer generating a strained 2D lattice of the seed layer and resulting in an atomic rearrangement of the seed layer in three-dimensional (3D) space to create localised electronic states to form electric potential wells for bonding the adatoms to the surface of the seed layer via the vdW interaction to form the layer of material.

27. The method of claim 26, wherein the seed layer comprises two or more layers of homogenous 2D monolayer amorphous carbon and is formed on a substrate, the method further comprises controlling a number of layer of homogenous 2D monolayer amorphous carbon to tune the vdW interaction between the seed layer and the layer of material and to remotely modulate an interaction between the substrate and the adatoms for forming the layer of material during growth.