SUMMARY

[0007] An aspect of the present disclosure provides a sputtering system comprising: a first electrode comprising an elongated tube having a first end and a second end downstream of the first end, wherein the first end is configured to receive a gas flow and the second end is placed next to a substrate; a magnet surrounding at least a portion of the elongated tube and configured to generate a magnetic field in a space within the elongated tube; and a second electrode disposed within the elongated tube, wherein the first and second electrodes are made of different materials. A voltage is configured to be applied between the first and second electrodes to generate an electric field between the first and second electrodes. A direction of the electric field between the first and second electrodes is alternated in use for depositing alternating layers of sputtered materials onto the substrate, the sputtered materials comprising the different materials.

[0008]

[0009]

[0010] At least one of the first and second electrodes may be made of a transition metal, and the gas flow may comprise a chalcogen vapor.

[0011] The transition metal may comprise Molybdenum or Tungsten.

[0012] The tube may be substantially cylindrical and the second electrode may comprise a rod disposed along a longitudinal axis of the tube.

[0013] The system may further comprise control means for controlling at least one of a partial pressure of the gas flow, a strength of the magnetic field, a strength of the electric field, a sputtering duration, and a temperature of the substrate.

[0014] Another aspect of the present disclosure provides a sputtering method. The method comprises providing a sputtering system. The sputtering system comprises a first electrode comprising an elongated tube having a first end and a second end downstream of the first end, wherein the second end is disposed adjacent a substrate; a magnet surrounding at least a portion of the elongated tube; and a second electrode disposed within the elongated tube, wherein the first and second electrodes are made of different materials. The method also includes generating a sputtered

material, wherein generating comprises: generating a magnetic field in a space within the elongated tube using the magnet; applying a voltage between the first and second electrodes to generate an electric field between the first and second electrodes; and supplying a gas flow to the first end of the elongated tube to generate a discharge. The method further includes depositing the generated sputtered material exiting the second end of the elongated tube onto the substrate, and alternating a direction of the electric field between the first and second electrodes for depositing alternating layers of sputtered materials onto the substrate, the sputtered materials comprising the different materials.

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[0017] Providing the sputtering system may further comprise selecting at least one of the first and second electrodes to be made of a transition metal, and supplying the gas flow may comprise supplying a chalcogen vapor in the gas flow.

[0018] The transition metal may comprise Molybdenum or Tungsten.

[0019] Providing the sputtering system may further comprise providing a substantially cylindrical tube and disposing a rod along a longitudinal axis of the tube.

[0020] The method may further comprise controlling at least one of a partial pressure of the gas flow, a strength of the magnetic field, a strength of the electric field, a sputtering duration, and a temperature of the substrate.

[0021] Depositing the generated sputtered material may comprise depositing the material as a two-dimensional (2D) film.

CLAIMS

1. A sputtering system comprising:

a first electrode comprising an elongated tube having a first end and a second end downstream of the first end, wherein the first end is configured to receive a gas flow and the second end is placed next to a substrate;

a magnet surrounding at least a portion of the elongated tube and configured to generate a magnetic field in a space within the elongated tube; and

a second electrode disposed within the elongated tube, wherein the first and second electrodes are made of different materials,

wherein a voltage is configured to be applied between the first and second electrodes to generate an electric field between the first and second electrodes; and

wherein a direction of the electric field between the first and second electrodes is alternated in use for depositing alternating layers of sputtered materials onto the substrate, the sputtered materials comprising the different materials.

2. The sputtering system as claimed in claim 1, wherein at least one of the first and second electrodes is made of a transition metal, and wherein the gas flow comprises a chalcogen vapor.

3. The sputtering system as claimed in claim 2, wherein the transition metal comprises Molybdenum or Tungsten.

4. The system as claimed in claim 3, wherein the first electrode comprises Molybdenum (Mo), the second electrode comprises Tungsten (W), and the chalcogen vapour comprises Sulphur (S) vapour, and wherein the alternating layers of sputtered materials comprise alternating WS_2 and MoS_2 layers.

5. The sputtering system as claimed in any one of the preceding claims, wherein the tube is substantially cylindrical and the second electrode comprises a rod disposed along a longitudinal axis of the tube.

6. The sputtering system as claimed in any one of the preceding claims, further comprising control means for controlling at least one of a partial pressure of the gas flow, a strength of the magnetic field, a strength of the electric field, a sputtering duration, and a temperature of the substrate.

7. A sputtering method comprising:

providing a sputtering system, the system comprising:

a first electrode comprising an elongated tube having a first end and a second end downstream of the first end, wherein the second end is disposed adjacent a substrate;

a magnet surrounding at least a portion of the elongated tube; and

a second electrode disposed within the elongated tube, wherein the first and second electrodes are made of different materials;

generating a sputtered material, wherein generating comprises:

generating a magnetic field in a space within the elongated tube using the magnet;

applying a voltage between the first and second electrodes to generate an electric field between the first and second electrodes; and

supplying a gas flow to the first end of the elongated tube to generate a discharge;

depositing the generated sputtered material exiting the second end of the elongated tube onto the substrate; and

alternating a direction of the electric field between the first and second electrodes for depositing alternating layers of sputtered materials onto the substrate, the sputtered materials comprising the different materials.

8. The sputtering method as claimed in claim 7, wherein providing the sputtering system further comprises selecting at least one of the first and second electrodes to be made of a transition metal, and wherein supplying the gas flow comprises supplying a chalcogen vapor in the gas flow.

9. The sputtering method as claimed in claim 8, wherein the transition metal comprises Molybdenum or Tungsten.

10. The method as claimed in claim 9, wherein the first electrode comprises Molybdenum (Mo), the second electrode comprises Tungsten (W), and the chalcogen vapour comprises Sulphur (S) vapour, and wherein depositing alternating layers of sputtered materials comprises depositing alternating WS_2 and MoS_2 layers.

11. The sputtering method as claimed in any one of claims 7 to 10, wherein providing the sputtering system further comprises providing a substantially cylindrical tube and disposing a rod along a longitudinal axis of the tube.

12. The sputtering method as claimed in any one of claims 7 to 11, further comprising controlling at least one of a partial pressure of the gas flow, a strength of the magnetic field, a strength of the electric field, a sputtering duration, and a temperature of the substrate.

13. The sputtering method as claimed in any one of claims 7 to 12, wherein depositing the generated sputtered material comprises depositing the material as a two-dimensional (2D) film.