embodiment at least 100% greater in thickness. Fig. 3 shows 2/3 greater in thickness.

[0034] The tellurium-comprising precursor used to form the construction of Fig. 3 from that of Fig. 2 may be organic or inorganic. Additionally, a combination of organic and inorganic tellurium-comprising precursors may be used. Example substrate temperature and chamber pressure ranges include from 200°C to 450°C, and pressure from 0.1mTorr to 760Torr. An example inorganic gaseous tellurium-comprising precursor is TeH_2. Example organic gaseous tellurium-comprising precursors include di-tert-butyl telluride, tellurium IV ethoxide, and tetrakis dimethylamido tellurium. In one embodiment, the organic gaseous tellurium-comprising precursor is void of NR_2., where R is organic. Regardless, in one embodiment, the tellurium-comprising precursor is void of nitrogen. Substrate temperature during the deposition may be tailored for the specific tellurium-comprising precursor used, for example being a temperature of at least 360°C for a di-tert-butyl telluride, and at least 260°C for a tellurium IV ethoxide. Either of such may be flowed to a chamber within which the substrate is received by using a bubbler/vaporizer, or by flowing or spraying a liquid into the chamber under chamber pressure conditions wherein vaporization rapidly occurs.

[0035] In one ideal embodiment, formation of the germanium and tellurium-comprising compound of phase change material 14 is chemical vapor deposited in a self-limiting manner. For example, the gaseous tellurium-comprising precursor is fed to the germanium-comprising material until no more of the germanium and tellurium-comprising compound is formed, for example due to no more elemental-form germanium being available within germanium-comprising material 12 of Fig. 2 for reaction, and thereby self-limits in thickness growth. In one embodiment, the flowing of the tellurium-comprising precursor is continued for at least 10 seconds after no more of the compound is formed, for example to assure that reaction has been complete. Some tellurium may be removed in elemental-form from the precursor over phase change material 14 from continued flowing of the gaseous tellurium-

Fig. 2. Example thickness ranges and methods of deposition include those described above.

[0044] Referring to Fig. 11, a gaseous tellurium-comprising precursor has been flowed to the germanium-comprising material of Fig. 10 within opening 42 and outside of opening 42. Tellurium has been removed from the gaseous precursor to react with the elemental-form germanium in material 12a to form a germanium and tellurium-comprising compound of a tellurium-comprising phase change material 14a. Composition of material 14a may be the same as that described above from material 14. Rate of formation of the germanium and tellurium-comprising compound is less proximate the base of opening 42 as compared to outside of opening 42. The dashed line in Fig. 11 shows the outermost extent of germanium-comprising material 12a of Fig. 10. As is apparent from the Fig. 11 example, thickness of phase change material 14a deeper within opening 42 is less as compared to higher within opening 42 and outwardly thereof due to different rate of formation at least outwardly of opening 42 as compared to deeper within opening 42. Rate of formation of the germanium and tellurium-comprising compound may or may not be uniform deeper within opening 42, and may form thicker than shown at lower portions of opening 42 as compared to intermediate portions of opening 42.

[0045] Referring to Fig. 12, flowing of the gaseous tellurium-comprising precursor has been continued beyond a point where no more of the compound is formed outside of opening 42 but has continued to be formed within opening 42 whereby the forming of the germanium and tellurium-comprising compound self-limits in thickness, for example outwardly and inwardly of opening 42. An example resultant phase change material 14a of substantial uniform thickness is shown in Fig. 12. Composition and processing to produce phase change material 14a may be as described in the above embodiments. Processing may comprise one or a combination of CVD and ALD.

[0046] Referring to Fig. 13, outer electrode material 34a has been formed over tellurium-comprising phase change material 14a, thus forming a phase change memory cell 35a. Further and regardless, a phase change material may

CLAIMS:

1. A method of forming a tellurium alkoxide, comprising:

providing a tellurium halide and a non-tellurium alkoxide in a liquid organic solvent, the liquid organic solvent comprising less moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent;

reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent to form a reaction product halide and a tellurium alkoxide;

removing the liquid organic solvent from the reaction product halide and the tellurium alkoxide to leave a liquid and/or solid mixture comprising the reaction product halide and the tellurium alkoxide; and

heating the mixture effective to gasify the tellurium alkoxide from the reaction product halide.

2. The method of claim 1 wherein the removing forms a solid-comprising mixture which comprises the reaction product halide and the tellurium alkoxide, the heating comprising subliming the tellurium alkoxide from the reaction product halide.

3. The method of claim 1 wherein the removing forms a liquid comprising mixture which comprises the reaction product halide and the tellurium alkoxide, the heating comprising vaporizing the tellurium alkoxide from the reaction product halide.

4. The method of claim 1 wherein the removing forms a liquid and solid-comprising mixture which comprises the reaction product halide and the tellurium alkoxide.

5. The method of claim 1 wherein the liquid organic solvent comprises no greater than 50% moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent.

6. The method of claim 1 wherein the liquid organic solvent comprises no greater than 10% moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent.

7. The method of claim 1 wherein the liquid organic solvent is void of detectible alcohol.

8. The method of claim 1 wherein the liquid organic solvent comprises a mixture of different composition organic solvent compounds.

9. The method of claim 1 wherein the reacting occurs at room ambient temperature.

10. The method of claim 1 wherein the reacting occurs at room ambient pressure.

11. The method of claim 1 comprising also reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent to form a mixed halide-alkoxide of tellurium.

12. The method of claim 1 wherein the removing comprises vaporizing the liquid organic solvent.

13. The method of claim 1 wherein the liquid organic solvent comprises at least one of a toluene, an ether, tetrahydrofuran, dimethyl sulfoxide, and acetonitrile.

14. The method of claim 1 wherein the liquid organic solvent comprises at least one of a pentane and a hexane.

15. The method of claim 1 wherein the non-tellurim alkoxide comprises at least one of a methoxide, an ethoxide, and a tert-butoxide.

16. The method of claim 1 wherein the reacting occurs while stirring the liquid organic solvent.

17. The method of claim 1 wherein the reacting forms some of the tellurim alkoxide to be dissolved in the organic solvent and some of the tellurium alkoxide as solid precipitate.

18. The method of claim 1 wherein said providing comprises:

forming a first mixture comprising tellurium halide and liquid organic solvent in the absence of non-tellurium alkoxide;

forming a second mixture comprising non-tellurium alkoxide and liquid organic solvent in the absence of tellurium halide; and

combining the first and second mixtures.

19. A method of forming a tellurium alkoxide, comprising:

providing a tellurium halide and a non-tellurium alkoxide in a liquid organic solvent mixture; the liquid organic solvent mixture comprising less moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent mixture; the liquid organic solvent mixture comprising a polar organic solvent and a non-polar organic solvent;

reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent mixture to form a reaction product halide and a tellurium alkoxide;

removing the liquid organic solvent mixture from the reaction product halide and the tellurium alkoxide to leave a liquid and/or solid mixture comprising the reaction product halide and the tellurium alkoxide; and

heating the liquid and/or solid mixture effective to gasify the tellurium alkoxide from the reaction product halide.

20. The method of claim 19 wherein the removing forms a solid-comprising mixture which comprises the reaction product halide and the tellurium alkoxide, the heating comprising subliming the tellurium alkoxide from the reaction product halide.

21. The method of claim 19 wherein the liquid organic solvent mixture in which the tellurium halide and the non-tellurium alkoxide are provided comprises from 1:1 to 20:1 by volume of polar organic solvent to non-polar organic solvent.

22. A method of forming a mixed halide-alkoxide of tellurium, comprising:

providing a tellurium halide and a non-tellurium alkoxide in a liquid organic solvent, the liquid organic solvent comprising less moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent;

reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent to form a reaction product halide and a mixed halide-alkoxide of tellurium;

removing the liquid organic solvent from the reaction product halide and the mixed halide-alkoxide of tellurium to leave a liquid and/or solid mixture comprising the reaction product halide and the mixed halide-alkoxide of tellurium; and

heating the mixture effective to gasify the mixed halide-alkoxide of tellurium from the reaction product halide.

23. The method of claim 22 wherein the liquid organic solvent comprises no greater than 10% moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent.

24. The method of claim 22 wherein the removing forms a solid-comprising mixture which comprises the reaction product halide and the tellurium alkoxide, the heating comprising subliming the tellurium alkoxide from the reaction product halide.

25. A method of forming a mixed halide-alkoxide of tellurium, comprising:

providing a tellurium halide and a non-tellurium alkoxide in a liquid organic solvent mixture; the liquid organic solvent mixture comprising less moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent mixture; the liquid organic solvent mixture comprising a polar organic solvent and a non-polar organic solvent;

reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent mixture to form a reaction product halide and a mixed halide-alkoxide of tellurium;

removing the liquid organic solvent mixture from the reaction product halide and the mixed halide-alkoxide of tellurium to leave a liquid and/or solid mixture comprising the reaction product halide and the mixed halide-alkoxide of tellurium; and

heating the liquid and/or solid mixture effective to gasify the mixed halide-alkoxide of tellurium from the reaction product halide.

26. The method of claim 25 wherein the removing forms a solid-comprising mixture which comprises the reaction product halide and the tellurium alkoxide, the heating comprising subliming the tellurium alkoxide from the reaction product halide.

embodiment at least 100% greater in thickness. Fig. 3 shows 2/3 greater in thickness.

[0034] The tellurium-comprising precursor used to form the construction of Fig. 3 from that of Fig. 2 may be organic or inorganic. Additionally, a combination of organic and inorganic tellurium-comprising precursors may be used. Example substrate temperature and chamber pressure ranges include from 200°C to 450°C, and pressure from 0.1mTorr to 760Torr. An example inorganic gaseous tellurium-comprising precursor is TeH_2. Example organic gaseous tellurium-comprising precursors include di-tert-butyl telluride, tellurium IV ethoxide, and tetrakis dimethylamido tellurium. In one embodiment, the organic gaseous tellurium-comprising precursor is void of NR_2, where R is organic. Regardless, in one embodiment, the tellurium-comprising precursor is void of nitrogen. Substrate temperature during the deposition may be tailored for the specific tellurium-comprising precursor used, for example being a temperature of at least 360°C for a di-tert-butyl telluride, and at least 260°C for a tellurium IV ethoxide. Either of such may be flowed to a chamber within which the substrate is received by using a bubbler/vaporizer, or by flowing or spraying a liquid into the chamber under chamber pressure conditions wherein vaporization rapidly occurs.

[0035] In one ideal embodiment, formation of the germanium and tellurium-comprising compound of phase change material 14 is chemical vapor deposited in a self-limiting manner. For example, the gaseous tellurium-comprising precursor is fed to the germanium-comprising material until no more of the germanium and tellurium-comprising compound is formed, for example due to no more elemental-form germanium being available within germanium-comprising material 12 of Fig. 2 for reaction, and thereby self-limits in thickness growth. In one embodiment, the flowing of the tellurium-comprising precursor is continued for at least 10 seconds after no more of the compound is formed, for example to assure that reaction has been complete. Some tellurium may be removed in elemental-form from the precursor over phase change material 14 from continued flowing of the gaseous tellurium-

Fig. 2. Example thickness ranges and methods of deposition include those described above.

[0044] Referring to Fig. 11, a gaseous tellurium-comprising precursor has been flowed to the germanium-comprising material of Fig. 10 within opening 42 and outside of opening 42. Tellurium has been removed from the gaseous precursor to react with the elemental-form germanium in material 12a to form a germanium and tellurium-comprising compound of a tellurium-comprising phase change material 14a. Composition of material 14a may be the same as that described above for material 14. Rate of formation of the germanium and tellurium-comprising compound is less proximate the base of opening 42 as compared to outside of opening 42. The dashed line in Fig. 11 shows the outermost extent of germanium-comprising material 12a of Fig. 10. As is apparent from the Fig. 11 example, thickness of phase change material 14a deeper within opening 42 is less as compared to higher within opening 42 and outwardly thereof due to different rate of formation at least outwardly of opening 42 as compared to deeper within opening 42. Rate of formation of the germanium and tellurium-comprising compound may or may not be uniform deeper within opening 42, and may form thicker than shown at lower portions of opening 42 as compared to intermediate portions of opening 42.

[0045] Referring to Fig. 12, flowing of the gaseous tellurium-comprising precursor has been continued beyond a point where no more of the compound is formed outside of opening 42 but has continued to be formed within opening 42 whereby the forming of the germanium and tellurium-comprising compound self-limits in thickness, for example outwardly and inwardly of opening 42. An example resultant phase change material 14a of substantial uniform thickness is shown in Fig. 12. Composition and processing to produce phase change material 14a may be as described in the above embodiments. Processing may comprise one or a combination of CVD and ALD.

[0046] Referring to Fig. 13, outer electrode material 34a has been formed over tellurium-comprising phase change material 14a, thus forming a phase change memory cell 35a. Further and regardless, a phase change material may

Claims

1. A method of forming a tellurium alkoxide, comprising:

providing a tellurium halide and a non-tellurium alkoxide in a liquid organic solvent, the liquid organic solvent comprising less moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent;

reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent to form a reaction product halide and a tellurium alkoxide;

removing the liquid organic solvent from the reaction product halide and the tellurium alkoxide to leave a liquid and/or solid mixture comprising the reaction product halide and the tellurium alkoxide; and

heating the mixture to gasify the tellurium alkoxide from the reaction product halide.

2. The method of claim 1 wherein the removing forms a solid-comprising mixture which comprises the reaction product halide and the tellurium alkoxide, the heating comprising subliming the tellurium alkoxide from the reaction product halide.

3. The method of claim 1 wherein the removing forms a liquid comprising mixture which comprises the reaction product halide and the tellurium alkoxide, the heating comprising vaporizing the tellurium alkoxide from the reaction product halide.

4. The method of claim 1 wherein the removing forms a liquid and solid-comprising mixture which comprises the reaction product halide and the tellurium alkoxide.

5. The method of claim 1 wherein the liquid organic solvent comprises no greater than 50% moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent.

6. The method of claim 1 wherein the liquid organic solvent comprises no greater than 10% moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent.

7. The method of claim 1 wherein the liquid organic solvent is void of detectible alcohol.

8. The method of claim 1 comprising also reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent to form a mixed halide-alkoxide of tellurium.

9. The method of claim 1 wherein the liquid organic solvent comprises at least one of a toluene, an ether, tetrahydrofuran, dimethyl sulfoxide, and acetonitrile.

10. The method of claim 1 wherein the liquid organic solvent comprises at least one of a pentane and a hexane.

11. The method of claim 1 wherein the non-tellurim alkoxide comprises at least one of a methoxide, an ethoxide, and a tert-butoxide.

12. The method of claim 1 wherein the reacting forms some of the tellurim alkoxide to be dissolved in the organic solvent and some of the tellurium alkoxide as solid precipitate.

13. The method of claim 1 wherein said providing comprises:

forming a first mixture comprising tellurium halide and liquid organic solvent in the absence of non-tellurium alkoxide;

forming a second mixture comprising non-tellurium alkoxide and liquid organic solvent in the absence of tellurium halide; and

combining the first and second mixtures.

14. A method of forming a tellurium alkoxide, comprising:

providing a tellurium halide and a non-tellurium alkoxide in a liquid organic solvent mixture; the liquid organic solvent mixture comprising less moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent mixture; the liquid organic solvent mixture comprising a polar organic solvent and a non-polar organic solvent;

reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent mixture to form a reaction product halide and a tellurium alkoxide;

removing the liquid organic solvent mixture from the reaction product halide and the tellurium alkoxide to leave a liquid and/or solid mixture comprising the reaction product halide and the tellurium alkoxide; and

heating the liquid and/or solid mixture to gasify the tellurium alkoxide from the reaction product halide.

15. The method of claim 14 wherein the removing forms a solid-comprising mixture which comprises the reaction product halide and the tellurium alkoxide, the heating comprising subliming the tellurium alkoxide from the reaction product halide.

16. A method of forming a mixed halide-alkoxide of tellurium, comprising:

providing a tellurium halide and a non-tellurium alkoxide in a liquid organic solvent, the liquid organic solvent comprising less moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent;

reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent to form a reaction product halide and a mixed halide-alkoxide of tellurium;

removing the liquid organic solvent from the reaction product halide and the mixed halide-alkoxide of tellurium to leave a liquid and/or solid mixture comprising the reaction product halide and the mixed halide-alkoxide of tellurium; and

heating the mixture to gasify the mixed halide-alkoxide of tellurium from the reaction product halide.

17. The method of claim 16 wherein the liquid organic solvent comprises no greater than 10% moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent.

18. A method of forming a mixed halide-alkoxide of tellurium, comprising:

providing a tellurium halide and a non-tellurium alkoxide in a liquid organic solvent mixture; the liquid organic solvent mixture comprising less moles of alcohol, if any, than moles of tellurium halide in the liquid organic solvent mixture; the liquid organic solvent mixture comprising a polar organic solvent and a non-polar organic solvent;

reacting the tellurium halide and the non-tellurium alkoxide within the liquid organic solvent mixture to form a reaction product halide and a mixed halide-alkoxide of tellurium;

removing the liquid organic solvent mixture from the reaction product halide and the mixed halide-alkoxide of tellurium to leave a liquid and/or solid mixture comprising the reaction product halide and the mixed halide-alkoxide of tellurium; and

heating the liquid and/or solid mixture to gasify the mixed halide-alkoxide of tellurium from the reaction product halide.