blank 400 further includes a capping layer 422 on the multilayer stack of reflective layers 412, and there is a multilayer stack 420 of absorber layers on the capping layer 422. In one or more embodiment, the plurality of reflective layers 412 are selected from a molybdenum (Mo) containing material and a silicon (Si) containing material and the capping layer 422 comprises ruthenium.

[0078] The multilayer stack 420 of absorber layers includes a plurality of absorber layer pairs 420a, 420b, 420c, 420d, 420e, 420f, each pair (420a/420b, 420c/420d, 420e/420f) comprising an alloy of carbon and antimony. In some embodiments, the alloy of carbon and antimony comprises about 3.0 wt.% to about 27.1 wt.% carbon and about 72.9 wt.% to about 97 wt.% antimony, for example, about 6.0 wt.% to about 15 wt.% carbon and about 85 wt.% to about 94 wt.% antimony, for example, about 90.6 wt.% antimony and about 9.4 wt.% carbon. In other embodiments, the alloy of carbon and antimony comprises about 35 wt.% to about 55 wt.% carbon and about 45 wt.% to about 65 wt.% antimony, for example, about 52 wt.% carbon and about 48 wt.% to about 55 wt.% antimony, for example, about 51.3 wt.% antimony and 48.7 wt.% carbon.

[0079] In one example, absorber layer 420a is made from antimony and the material that forms absorber layer 420b is carbon. Likewise, absorber layer 420c is made from antimony and the material that forms absorber layer 420d is carbon, and absorber layer 420e is made from antimony material and the material that forms absorber layer 420f is carbon.

[0080] In one embodiment, the extreme ultraviolet mask blank 400 includes the plurality of reflective layers 412 selected from molybdenum (Mo) containing material and silicon (Si) containing material, for example, molybdenum (Mo) and silicon (Si). The absorber materials that are used to form the absorber layers 420a, 420b, 420c, 420d, 420e and 420f are an alloy of carbon and antimony. In some embodiments, the alloy of carbon and antimony comprises about 3.0 wt.% to about 27.1 wt.% carbon and about 72.9 wt.% to about 97 wt.% antimony, for example, about 6.0 wt.% to about 15 wt.% carbon and about 85 wt.% to about 94 wt.% antimony, for example, about 90.6 wt.% antimony and about 9.4 wt.% carbon. In other embodiments, the alloy of carbon and antimony comprises about 35 wt.% to about 55 wt.% carbon and about 45 wt.% to about 65 wt.% antimony, for example, about 52 wt.% carbon and about 48

12:1, 13:1, 14:1, 15:1, 16:1, 17:1, 18:1, 19:1, or 20:1 which results in the second absorber layer having a thickness that is equal to or greater than the first absorber layer thickness in each pair.

[0083] According to one or more embodiments, the different absorber materials and thickness of the absorber layers are selected so that extreme ultraviolet light is absorbed due to absorbance and due to a phase change caused by destructive interfere with light from the multilayer stack of reflective layers. While the embodiment shown in FIG. 5 shows three absorber layer pairs, 420a/420b, 420c/420d and 420e/420f, the claims should not be limited to a particular number of absorber layer pairs. According to one or more embodiments, the EUV mask blank 400 can include in a range of 5 and 60 absorber layer pairs or in a range of 10 and 40 absorber layer pairs.

[0084] According to one or more embodiments, the absorber layers have a thickness which provides less than 2% reflectivity and other etch properties. A supply gas can be used to further modify the material properties of the absorber layers, for example, nitrogen (N_2) gas can be used to form nitrides of the materials provided above. The multilayer stack of absorber layers according to one or more embodiments is a repetitive pattern of individual thickness of different materials so that the EUV light not only gets absorbed due to absorbance but by the phase change caused by multilayer absorber stack, which will destructively interfere with light from multilayer stack of reflective materials beneath to provide better contrast.

[0085] Another aspect of the disclosure pertains to a method of manufacturing an extreme ultraviolet (EUV) mask blank comprising forming on a substrate a multilayer stack of reflective layers on the substrate, the multilayer stack including a plurality of reflective layer pairs, forming a capping layer on the multilayer stack of reflective layers, and forming absorber layer on the capping layer, the absorber layer comprising an alloy of carbon and antimony, wherein the alloy of carbon and antimony comprises about 3.0 wt.% to about 27.1 wt.% carbon and about 72.9 wt.% to about 97 wt.% antimony, for example, about 6.0 wt.% to about 15 wt.% carbon and about 85 wt.% to about 94 wt.% antimony, for example, about 90.6 wt.% antimony and about 9.4 wt.% carbon. In other embodiments, the alloy of carbon and antimony comprises about 35 wt.% to about 55 wt.% carbon and

about 45 wt.% to about 65 wt.% antimony, for example, about 52 wt.% carbon and about 48 wt.% to about 55 wt.% antimony, for example, about 51.3 wt.% antimony and 48.7 wt.% carbon. In one or more embodiments, the alloy of carbon and antimony is amorphous.

[0086] The EUV mask blank can have any of the characteristics of the embodiments described above with respect to FIG. 4 and FIG. 5, and the method can be performed in the system described with respect to FIG. 3.

[0087] Thus, in an embodiment, the plurality of reflective layers are selected from molybdenum (Mo) containing material and silicon (Si) containing material and the absorber layer is an alloy of carbon and antimony, wherein the alloy of carbon and antimony comprises about 3.0 wt.% to about 27.1 wt.% carbon and about 72.9 wt.% to about 97 wt.% antimony, for example, about 6.0 wt.% to about 15 wt.% carbon and about 85 wt.% to about 94 wt.% antimony, for example, about 90.6 wt.% antimony and about 9.4 wt.% carbon. In other embodiments, the alloy of carbon and antimony comprises about 35 wt.% to about 55 wt.% carbon and about 45 wt.% to about 65 wt.% antimony, for example, about 52 wt.% carbon and about 48 wt.% to about 55 wt.% antimony, for example, about 51.3 wt.% antimony and 48.7 wt.% carbon. In one or more embodiments, the alloy of carbon and antimony is amorphous.

[0088] In another specific method embodiment, the different absorber layers are formed in a physical deposition chamber having a first cathode comprising a first absorber material and a second cathode comprising a second absorber material. Referring now to FIG. 6 an upper portion of a multi-cathode source chamber 500 is shown in accordance with an embodiment. The multi-cathode chamber 500 includes a base structure 501 with a cylindrical body portion 502 capped by a top adapter 504. The top adapter 504 has provisions for a number of cathode sources, such as cathode sources 506, 508, 510, 512, and 514, positioned around the top adapter 504.

[0089] In one or more embodiments, the method forms an absorber layer that has a thickness in a range of 5 nm and 60 nm. In one or more embodiments, the absorber layer has a thickness in a range of 51 nm and 57 nm. In one or more embodiments, the materials used to form the absorber layer are selected to effect etch properties of the absorber layer. In one or more embodiments, The alloy of the absorber layer is

What is claimed is:

1. A method of manufacturing an extreme ultraviolet (EUV) mask blank comprising:

forming on a substrate a multilayer stack which reflects EUV radiation, the multilayer stack comprising a plurality of reflective layer pairs;

forming a capping layer on the multilayer stack; and

forming an absorber layer on the capping layer, the absorber layer comprising an alloy selected from the group consisting of an alloy consisting essentially of carbon and antimony and an alloy of consisting essentially of carbon, antimony and one or more of a nitrogen dopant and an oxygen dopant.

2. The method of claim 1, wherein the alloy of carbon and antimony comprises about 3.0 wt.% to about 27.1 wt.% carbon and about 72.9 wt.% to about 97 wt.% antimony.

3. The method of claim 1, wherein the alloy of carbon and antimony comprises about 35 wt.% to about 55 wt.% carbon and about 45 wt.% to about 65 wt.% antimony.

4. The method of claim 2, wherein the alloy of carbon and antimony comprises about 6.0 wt.% to about 15 wt.% carbon and about 85 wt.% to about 94 wt.% antimony.

5. The method of claim 3, wherein the alloy of carbon and antimony comprises about 45 wt.% to about 52 wt.% carbon and about 48 wt.% to about 55 wt.% antimony.

6. The method of claim 1, wherein the alloy is formed by co-sputtering the carbon and antimony with a gas selected from one or more of argon (Ar), oxygen (O_2), or nitrogen (N_2) to form the absorber layer.

7. The method of claim 1, wherein the alloy is deposited layer by layer as a laminate of carbon and antimony layers using a gas selected from one or more of argon (Ar), oxygen (O_2), or nitrogen (N_2) to form the absorber layer.

8. The method of claim 1, wherein the alloy is deposited using a bulk target having the same composition as the alloy and is sputtered using a gas selected from one or more of argon (Ar), oxygen (O_2), or nitrogen (N_2) to form the absorber layer.

9. The method of claim 2, wherein the alloy of carbon and antimony is doped with one of more of nitrogen or oxygen in a range of from 0.1 wt.% to 5 wt.%.

10. The method of claim 3, wherein the alloy of carbon and antimony is doped with one of more of nitrogen or oxygen in a range of from about 0.1 wt.% to about 5 wt.%.

11. An extreme ultraviolet (EUV) mask blank comprising:

a substrate;

a multilayer stack which reflects EUV radiation, the multilayer stack comprising a plurality of reflective layer pairs;

a capping layer on the multilayer stack of reflecting layers; and

an absorber layer comprising an alloy selected from the group consisting of an alloy consisting essentially of carbon and antimony and an alloy consisting essentially of carbon, antimony and one or more of a nitrogen dopant and an oxygen dopant.

12. The extreme ultraviolet (EUV) mask blank of claim 11, wherein the alloy of carbon and antimony comprises about 3.0 wt.% to about 27.1 wt.% carbon and about 72.9 wt.% to about 97 wt.% antimony.

13. The extreme ultraviolet (EUV) mask blank of claim 11, the alloy of carbon and antimony comprises about 35 wt.% to about 55 wt.% carbon and about 45 wt.% to about 65 wt.% antimony.

14. The extreme ultraviolet (EUV) mask blank of claim 12, wherein the alloy of carbon and antimony comprises about 6.0 wt.% to about 15 wt.% carbon and about 85 wt.% to about 94 wt.% antimony

15. The extreme ultraviolet (EUV) mask blank of claim 13, wherein the alloy of carbon and antimony comprises about 45 wt.% to about 52 wt.% carbon and about 48 wt.% to about 55 wt.% antimony.

16. The extreme ultraviolet (EUV) mask blank of claim 11, wherein the absorber layer has a thickness of less than 45 nm.

17. The extreme ultraviolet (EUV) mask blank of claim 11, wherein the absorber layer further comprises a range of rom about 0.1 wt.% to about 5 wt.% of a dopant selected from one or more of nitrogen or oxygen.

18. The extreme ultraviolet (EUV) mask blank of claim 11, wherein the absorber layer has a thickness of less than 45 nm.

19. The extreme ultraviolet (EUV) mask blank of claim 11, wherein the absorber layer is etch selective relative to the capping layer.

20. An extreme ultraviolet (EUV) mask blank comprising:
a substrate;
a multilayer stack which reflects EUV radiation, the multilayer stack comprising a plurality of reflective layer pairs including molybdenum (Mo) and silicon (Si);
a capping layer on the multilayer stack of reflecting layers; and
an absorber layer comprising an alloy selected from the group consisting of an alloy consisting essentially of carbon and antimony and an alloy of carbon and antimony optionally doped with one or more of nitrogen and oxygen.