Stainless Steel	316L	2000°F for 2 hr	171
Steel	18% Ni Maraging 300	Stress-relieved	340
Steel	18% Ni Maraging 300	915°F for 6 hr	545
Steel	H13	Stress-relieved	613
Steel	H13	1076°F for 1 hr (x2)	653
Nickel-Based	Inconel 718	Stress-relieved	263
Nickel-Based	Inconel 718	AMS 5662	408
Titanium	Ti6Al4V	Stress-relieved	362
Titanium	Ti6Al4V	1725°F for 45 min	316

High hardness and wear resistance in components is desired for numerous applications to increase the durability (longevity) of the components in service. ~~The~~ Embodiments of the present invention ~~now identifies~~seek to identify alloys and corresponding manufacturing procedures that provide for a layered metallic material, prepared via a layer-by-layer build-up, that may indicate~~s~~ a unique combination of relatively high hardness and wear resistance. In addition, such properties can now be achieved by eliminating the use of the above referenced heat treating process applied to existing layer-by layer build-up of known metals. In addition, the properties herein ~~do~~ may not require quenching and/or tempering.

Summary

Layer-by-layer construction is applied to alloys to produce a relatively high hardness and wear resistant free-standing material. The alloys comprise ferrous alloy containing at least 50 at. % Fe and at least one element selected from the group consisting of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Al, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu; and at least one element selected from the group consisting of B, C, N, O, P, and S. The hardness values are in the range of 900-1800 HV and the wear resistance values are in the range of 6-53 mm^3 volume loss per ASTM G65-10 Procedure A, dated 2010. Such values ~~are~~ may be achieved without the need for post-treating of the layer-by-layer build up with heat followed by quenching and/or tempering. The layer-by-layer construction may allow~~s~~ for the formation of metallic components that may be utilized in applications such as pumps, valves and bearings.

The present disclosure ~~also more specifically~~ relates to a method of layer-by-layer construction of a metallic part comprising:

supplying an alloy in particle form comprising Fe at a level of 59.0 wt. % to 78.0 wt. %, B at a level of 3.0 wt. % to 5.0 wt. %, Cr at a level of 14.0 wt. % to 20.0 wt. %, C at a level of 0.5 wt. % to 7.0 wt. %, optionally Mo at a level of up to 11.0 wt. %, optionally Mn at a level of up to 2.5 wt. %, optionally Nb at a level of up to 4.5 wt. %, optionally Si at a level of up to 2.0 wt. %, optionally W at a level of up to 7.0 wt. %;

supplying a substrate;

applying one or more layers of said alloy onto said substrate by melting said alloy into a molten state and cooling and forming a solidified layer wherein each of said solid layers has a thickness as formed of 5.0 to 200.0 microns; and

optionally removing said substrate to form a free-standing metallic part and wherein said one or more solid layers indicates a hardness in the range of 900-1800 HV.

Brief Description of the Drawings

The above-mentioned and other features of this disclosure, and the manner of attaining them, will become more apparent and better understood by reference to the following description of embodiments described herein taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a SEM micrograph of ferrous alloy processed via PBF-L showing carbide and borocarbide phases present in Fe-rich matrix.

FIG. 2 contains an elemental map of Alloy 1 produced via PBF-L that shows the primary elements Fe, Cr, Nb, Si, Mo, Mn, and B contained within the various phases. The elemental map was generated via energy dispersive x-ray spectroscopy in a scanning electron microscope.

FIG. 3 illustrates a section of a relatively high-hardness ferrous material (hardness of 1250 HV) layerwise constructed with non-optimized parameters.