e. substantial material heat comes from shear forces which are localized at the walls and not uniformly distributed through the material

f. when the machine stops cycling for whatever reason (and material stops being fed/discharge) the heat balance changes

[11] All these characteristics make it difficult to maintain a metallic alloy in a processable (narrow) temperature regime. These characteristics are less prohibitive when processing plastics because the processable melt range occurs over a much larger temperature range and the resistance/strength of a cooling plastic is much less than that of metal and can often be more easily overcome by the force of the machine/screw.

SUMMARY OF THE INVENTION

[11a] According to a first aspect, there is provided a metal alloy feedstock for metal injection molding in an injection molding machine having a heated barrel, the heated barrel having a temperature gradient, the feedstock comprising: a first composition having a first melting point, wherein the first composition is a metal alloy formed from elements selected from the group consisting of aluminum, copper, silicon and zinc; a second composition having a second melting point higher than the first melting point of the first composition; the first melting point and the second melting point matching to the temperature gradient of the heated barrel; whereby when fed into the injection molding machine the first composition melts prior to the second composition melts and enabling the second composition to solute into the first composition.

[11b] According to a second aspect, there is provided a method of metal injection molding on an injection molding machine having a heated barrel with an increasing temperature gradient, the method comprising: providing a metal alloy feedstock including a first composition having a first melting point and a second composition having a second melting point that is higher than the first melting point, the first melting point and the second melting point selected to match the temperature gradient of the heated barrel of the injection molding machine; feeding the metal alloy feedstock into the injection molding machine; melting the metal alloy feedstock within the heated barrel of the injection molding machine; and maintaining the percentage of solids to liquids in the metal alloy feedstock of the first composition and second composition within a processable range of about 5% to about 30%, wherein the first composition is selected to include a metal alloy formed from elements selected from the group consisting of aluminum, copper, silicon and zinc.

[11c] According to a third aspect, there is provided a method of selecting metal alloys for use in a metal injection molding process, comprising: selecting a first composition having a first melting point, wherein the first composition is selected to include a metal alloy formed from elements selected from the group consisting of aluminum, copper, silicon and zinc; selecting a second composition having a second melting point higher than the first melting point; the first melting point and the second melting point selected to match a temperature gradient of a heated barrel of an injection molding machine; and whereby when the first composition and the second composition are processed in the injection molding machine the percentage of solids to liquids of the first composition and second composition remain within a processable range of about 5% to about 30%.

[12] Embodiments of tThe present invention seek to solves the problems of the prior art by providing a multi-component composition with at least a first component with a low melting point and a second component with a higher melting point selected to match with the temperature gradient of a barrel of an plastics injection molding machine. More than two components can be provided. Because of its lower melting point, the first component liquefies first and facilitates the transition of the second component into the liquidus mixture to reduce binding in the injection molding machine. In particular, the first component becomes liquid and its temperature is increased as it moves forward along the length of the barrel by the injection molding machine screw. The second component becomes soluble in the liquid of the first composition. If additional components are used, the additional components become soluble in the first composition also. The additional components are selected to have a melting point greater than the melting point of the first component, but less than the melting point

of the second component. The process continues with increasing temperature up to the liquidus temperature of the second component. All this time the composition of the liquid is changing because it has an equilibrium solubility that is temperature dependent. As the composition changes it also has an increasing liquidus temperature. Therefore, the composition is somewhat self-regulating. As the temp increases more of the second (high melting component is soluble). The dissolution of the second component changes the liquid composition and raises its liquidus temperature, thereby requiring even high temperature to incorporate more of the second composition. Similarly, if more than two components are used a similar equilibrium is reached. This means that the near liquid composition steps up at nearly the equilibrium liquidus line with increasing temperature (or length down the barrel of the injection molding machine). As a result, embodiments of the present invention provides a multi-component composition of metal useable in an injection molding machines to facilitate the molding of metal parts.

BRIEF DESCRIPTION OF THE DRAWINGS

[13] These and other features, aspects, and advantages of the present invention will become better understood with reference to the following description, appended claims, and accompanying drawings where:

[14] Fig. 1 is a binary phase diagram of a zinc-aluminum metal alloy made in accordance with the method of the present invention;

[15] Fig. 2 is a close up view of Inset A of Fig. 1;

[16] Fig. 3 shows a close up view of Inset A of Fig. 1 with a reference point B indicating the 95wt% zinc/ 5wt% aluminum eutectic;