CLAIMS:

1. A high-temperature die casting die comprising:

a first die plate with a first recess; and

a second die plate with a second recess, the first and second recesses defining a main part cavity and gating; and

a grain selector in fluid communication with the main cavity.

2. The high-temperature die casting die of claim 1, further comprising a chiller adapted to directionally apply a localized thermal gradient along the grain selector and the main part cavity.

3. The high-temperature die casting die of claim 2, further comprising a heat source disposed adjacent an exterior surface of the die casting die.

4. The high-temperature die casting die of claim 1, wherein the grain selector is configured as a part of the gating.

5. The high-temperature die casting die of claim 1, wherein the grain selector is configured as a seed crystal disposed in the main cavity.

6. A high-temperature die casting apparatus comprising:

a die casting die having a recess for solidifying a casting, the recess including gating in fluid communication with a main cavity; and

a chiller adaptable to directionally apply a localized thermal gradient from a first end to a second end of the casting.

7. The high-temperature die casting apparatus of claim 6, further comprising a heat source adaptable to cooperate with the chiller to directionally apply the localized thermal gradient.

8. The apparatus of claim 7, wherein the chiller and heat source are disposed adjacent the die to directionally apply the localized thermal gradient to the casting through the die.

9. The apparatus of claim 7, wherein the chiller and heat source are disposed adjacent the casting after ejection from the die to directionally apply the localized thermal gradient to the casting.

10. The high-temperature die casting apparatus of claim 6, wherein the gating includes a grain selector.

11. The high-temperature die casting die apparatus of claim 6, wherein a grain selector configured as a seed crystal is disposed in the main part cavity.

12. A method of die casting a metal alloy having a melting temperature of at least 1500° F (815° C), the method comprising the steps of:

injecting molten alloy into gating and a main part cavity of a die casting die;

solidifying the molten alloy in the main part cavity to form a casting; and

directionally applying a localized thermal gradient to the casting.

13. The method of claim 12, wherein the solidifying step comprises performing the directional applying step on the molten alloy injected into the die casting die to solidify the molten alloy directly into the casting having a first grain orientation.

14. The method of claim 13, wherein a grain selector is disposed in the main part cavity or as part of the gating, and wherein the directional applying step comprises first directionally applying the localized thermal gradient through a portion of molten alloy proximate the grain selector, and then through a remainder of the molten alloy to solidify the molten alloy directly into a single crystal.

15. The method of claim 14, further comprising:

prior to the directional applying step, removing the casting from the die casting die;

wherein the directional applying step results in zone refining of the casting.

16. The method of claim 12, wherein the localized thermal gradient is directionally applied at least in part by moving a heat source and a chiller relative to the casting.

17. The method of claim 12, wherein the alloy has a predominant element selected from the group: iron, nickel, cobalt, and titanium.

18. The method of claim 17, wherein the alloy has a predominant element of nickel.

19. A high-temperature directionally solidified die casting made according to the method of claim 13.

20. A high-temperature single-crystal die casting made according to the method of claim 14.

CLAIMS

1. A high-temperature die casting die comprising:

a first die plate with a first recess; and

a second die plate with a second recess, the first and second recesses defining a main part cavity and gating;

a grain selector in fluid communication with the main cavity; and

an in situ zone refining apparatus adapted to apply a localized thermal gradient to at least one of the first and second die plates, the localized thermal gradient and the die plates movable relative to each other so as to apply the localized thermal gradient along a first direction extending from the grain selector longitudinally across the main part cavity;

wherein the localized thermal gradient induces a movable solidification front in a metal disposed in the main part cavity such that a portion of the metal above the solidification front remains above a γ/γ' solvus temperature of the metal as the localized thermal gradient is applied along the first direction.

2. The high-temperature die casting die of claim 1, wherein the in situ zone refining apparatus comprises a chiller adapted to directionally apply localized thermal gradient along the grain selector and the main part cavity.

3. The high-temperature die casting die of claim 2, wherein the in situ zone refining apparatus comprises a heat source disposed adjacent an exterior surface of the die casting die, the heat source adapted to maintain an elevated temperature in the main part cavity ahead of the chiller.

4. The high-temperature die casting die of claim 1, wherein the grain selector is configured as a part of the gating.

5. The high-temperature die casting die of claim 1, wherein the grain selector is configured as a seed crystal disposed in the main cavity.