CLAIMS:

1. A method for preparing molten metals for casting, said method comprising:

(a) Having a melt of a metal or alloy that is initially above the liquidus temperature in a container;

(b) Placing at least one heat extraction probe into the melt to remove a controlled amount of heat and applying vigorous convection to the melt to assure nearly uniform cooling of the melt;

(c) Removing the heat extraction probe from the cooled melt when the cooled melt reaches a superheat temperature in the range of zero to less than 10 degree Celsius, in order to substantially stop further cooling; and

(d) Transferring the cooled melt at the superheat temperature in the range of zero to less than 10 degree Celsius into a secondary container for casting.

2. The method of Claim 1, wherein the container is in the form of a crucible or ladle, which is made of a material and is at a temperature such that it extracts heat from the melt at a significantly lower rate than does the heat extraction probe.

3. The method of Claim 1, wherein a part of the melt may be cooled sufficiently below the liquidus temperature for solid nuclei to form.

4. The method of Claim 1, wherein the time period from entry of the heat extracting probe into the melt to entry of the cooled melt into the secondary container is less than 60 seconds.

5. The method of Claim 3, wherein the fraction of solid nuclei formed in the cooled melt is less than 0.05 by weight.

6. The method of Claim 1, wherein the vigorous convection in the melt is achieved by gas flow by bubbling an inert gas through the heat extracting probe at the flow rate of 2 to 10 liter per minute.

7. The method of Claim 1, wherein the vigorous convection in the melt is achieved by rotation of the heat extracting probe or stirring of the melt by the heat extracting probe.

8. The method of Claim 1, wherein the vigorous convection in the melt is achieved by vibration of the heat extracting probe.

9. The method of Claim 1, wherein the vigorous convection in the melt is achieved by bubbling an inert gas through the heat extracting probe at a flow rate of 2 to 10 liter per minute, rotation of the heat extracting probe, stirring of the melt by the heat extracting probe, vibrating of the heat extracting probe, or a combination thereof.

10. The method of Claim 6, wherein the heat extracting probe is porous and provides for a multiplicity of gas outlets designed to dispense an inert gas into the melt.

11. The method of Claim 1, wherein the melt is cooled down at a rate of more than 10 degree Celsius per minute during the immersion of the heat extraction probe in the melt.

12. The method of Claim 1, wherein the superheat temperature of the melt after removing the probe is in the range of zero to less than 5 degree Celsius.

13. The method of Claim 1, wherein said heat extraction probe is made of graphite, ceramics, metals, or composites of these materials.

14. The method of Claim 1, wherein said container is made of graphite, ceramics, metals, or composites of these materials.

15. The method of Claim 1, wherein said metal or alloy is selected from the group consisting of aluminum, magnesium, copper, iron, zinc, lead, tin, nickel, silver, gold, titanium, or a combination thereof.

16. The method of Claim 1, wherein the secondary container is a mold assembly.

17. The method of Claim 16, wherein the mold assembly includes a shot sleeve and the cooled melt is transformed directly to the shot sleeve.
18. The method of Claim 1, wherein the desired temperature is a temperature above the liquidus temperature.