

Research Article

Method of Producing Single-crystal Structures

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Abstract

Every year, the topic of growing single crystals becomes more and more relevant. Scientific and technological progress is rapidly moving into the future, and the technologies for growing single crystals remain unchanged for a long time. This article describes quite comprehensively and simply the process of growing single crystals by saturating the melting tank with free electrons, using the physical properties of some step-up transformers. In particular, a car ignition coil is a transformer capable of generating an electric charge that is easily transferred to a device or objects that are technologically unrelated to each other. The proposed method for obtaining single crystal structures is interesting in that the size of the resulting product is limited only by the size of the casting mold or the volume of the melting tank. Constantly growing demand forces manufacturers to expand production, automate most production processes, burn a large amount of non-renewable energy sources, create mountains of waste, and at the same time the cost of grown single crystals remains consistently high. The technology described in this article is able to solve most of the economic and environmental problems of industrial production of single crystals.

Keywords

Single Crystal, Single Crystal Production, New Technology

1. Introduction

Each method of growing single crystals, each technological process, technology is interesting and worthy of study and analysis. I propose to consider the current technological process of manufacturing a metal single-crystal ribbon in order to better understand the essence of the method I proposed.

2. Description of the Existing Process

A machine that contains a metal drum with a smooth surface that rotates rapidly, through a calibrated hole in a quartz flask that is heated by an induction heater, a molten metal or a molten mixture is fed. The metal or mixture, getting onto the drum, is drawn into a ribbon, while the rapid cooling of the melt on the drum fixes its amorphous state. [2, 10-13]. The

entire process of forming a single crystal takes place in an inert environment. The process is logical and understandable.

2.1. This Same Process from a Different Angle

The design of the machine has a rapidly rotating metal drum. At one time, Nikola Tesla described the process that occurs during the rapid rotation of metal disks, when centrifugal forces generate an electric charge on their surface. There is even a corresponding US patent for his disk generator. [1] Let's remember this moment. A metal drum, rotating rapidly, generates free electrons on its surface, creating a potential with a "+" sign. At that time, molten metal (or its mixture) is fed to the disk, having a negative potential, that is,

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with a "-" sign. We know that unlike potentials attract, which is why the melt sticks to the surface of the rotating disk.

At the moment when the melt touches the surface of the disk, it (the melt) receives a charge of free electrons, which in turn prevent the formation of a crystal lattice of the ribbon during its cooling on the surface of the rotating drum.

If we consider the entire process of forming a single crystal from this point of view, we can draw a logical conclusion - it is the presence of free electrons in the melt environment that prevents the formation of a crystal lattice. This is the decisive factor in the formation of a single crystal. Neither the speed of rotation of the disk nor its temperature play any role in its formation.

We looked at the already existing, well-tuned process for producing metal ribbon with a single-crystal structure from a different perspective. Where the formation of a single crystal has a different explanation than the official one.

Following this logic further, we simplify the technological process of obtaining a single crystal.

We apply an electric charge to the crucible of the metal melt or its mixture until it cools completely. During the cooling process, the constant saturation of the crucible volume with free electrons prevents the formation of a crystal cluster. Thus, we can form a single crystal, the size of which is limited only by the volume of the container in which the metal melt or its mixture is located.

2.2. A very Important Point to Understand

The saturation of the melting crucible, the melting volume with an electric charge should not be and is not correct to compare with the conversion melting of metal and the processes that occur in this case. Free saturation with electrons does not involve their vector movement, such as from "phase to zero", from "plus to minus", and is provided by some types of step-up transformers. Everyone knows, and as an example of such a transformer, there is a car ignition coil, [3, 4] which combines two windings - primary and secondary. The primary winding has from one hundred to two hundred turns of thick copper wire. To protect against short circuits, the wire is insulated. The primary winding has two low-voltage terminals on the coil cover.

The secondary winding has from fifteen to thirty thousand turns of thin copper wire. It is located inside the primary winding. One end of the secondary winding is connected to the negative terminal of the primary winding, the other to the central terminal on the cover, which provides a high voltage output. To increase the strength of the magnetic field, the windings are arranged around an iron core. The windings, together with the core, are placed in a housing with an insulating cover. For better distribution and heat dissipation, the coil is filled with transformer oil.

The operation of the coil is based on the occurrence in the secondary winding of a high voltage of 25...35 kV when a low-voltage current pulse (usually 12 V) passes through the

primary winding. When the current passes through the primary winding, a magnetic field is created. When the primary winding circuit is opened, the magnetic field induces a high-voltage current in the secondary winding, which is output through the central terminal of the coil. It is the design of such a transformer as a car ignition coil that allows you to transfer an electric charge to objects that are not structurally connected to each other. And this is an important point of this simulated technology.

The saturation of the melt occurs through a discharge or gas discharge device, preferably with an adjustable spark gap.

2.3. Chemically Pure Single Crystal of Metal

The technological process just described logically allows modeling other situations with saturation of melts.

For example, if during metal melting the crucible volume is saturated with free electrons, even without an inert medium, we will obtain a chemically pure single crystal of metal.

Let us consider the process in more detail. The mixture of molten metal is divided into metal - a conductor, and dielectric impurities - which play the role of a dielectric-storage. A free electron in the melt is constantly transferred by the metal-conductor to the storage-dielectric (impurities). After a certain time, the dielectric impurities are oversaturated with charge and the process of separation into centers of metal and impurities begins in the melt. After a certain period of time of melting of the metal and simultaneous saturation of the melting volume with an electric charge, the pure metal concentrates near the center of the electric charge supply (for example, from the bottom of the melting tank), and the impurities, carrying the charge transferred from the metal, form a boundary between the metal single crystal and the environment, into which electrons are released in this process.

3. Result

3.1. Advantages

The main advantage of the proposed technology for growing single crystals of metal and its mixtures is that it can be applied to almost all types of foundry production without changing their main technological process. If the foundry mold provides for a complex configuration of the cast workpiece, then in this case it is possible to combine several centers of charge supply to the melt, thus controlling the direction of growth of the single crystal.

Since, as usual, molds for casting blanks have a porous structure, this fact makes it possible to quickly change the center of supply to the melt of an electric charge due to a high-voltage current, for which the porous structure of the mold for casting is not an insulator.

The advantage and convenience of the device itself for supplying an electric charge to the melt. After all, modern materials and electronics allow you to make the device light

and mobile. Another advantage over other methods of growing single crystals may be the speed of single crystal formation during this technological process and the relative simplicity of the process itself.

Another significant advantage of the proposed technology for growing single crystals is that its effectiveness is easy to verify in a conventional laboratory. A car ignition coil, a 1-4 μF 400 volt capacitor, a conventional household dimmer are connected as shown in the diagram (link to the video is given below) [5], (or as shown [14, 15]), a 220 volt household source, this is a simple generator for saturating with free electrons. A device for induction heating. A crucible with molten metal is simply on a laboratory table into which an electric charge is supplied from an improvised generator through a well-insulated conductor, directly into the molten mixture until it cools completely. For this experiment, it is not even necessary to create an inert environment. When the melt solidifies, all that remains is to saw the test sample, grind it and look at the structure under a microscope. Even such a primitive experiment will show the effectiveness of this technology. I hope I don't need to emphasize that the experiment involves high voltage and high melt temperatures, which require personal safety measures.

3.2. Disadvantages

The main significant disadvantage of the proposed method is that single crystals can be grown using this method only from metals and their mixtures. After all, a melt, for example, silicon, is saturated with free electrons, it is an explosive and unstable mixture. Therefore, melts of dielectric elements are not suitable for growing single crystals using this technology.

4. Conclusion

The proposed technology can significantly change the picture of the melting industry and technologies associated with the use of metal single crystal structures. Its simplicity and mobility make it possible to organize the production of single crystals in almost every foundry without violating the main technological process and without requiring additional technical conditions.

The ability to use multiple charge supply centers to control the growth and growth direction of a single crystal in complex casting molds.

Changing the frequency, speed and power of saturation of the metal melt opens up new ways for modeling the physical and chemical structure of the resulting product for researchers for many years to come.

The proposed technology, as an element, can be combined with existing technologies. For example, growing a silicon single crystal using the Czochralski method, [6-9], where a small saturation of the silicon melt during the process of growing a single crystal will help stabilize the internal stress of the finished product, thereby preventing the emergence of

one of the shortcomings of the existing technology.

And most importantly, this is the availability and relative cheapness of the proposed technological process, which is a significant factor against the background of constant demand due to rapid technological progress.

I hope that you, as a specialist, found my analytical research interesting. I thank you for taking a minute of your time and reading this article to the end. And I believe that the proposed technology can significantly change the picture of the smelting industry and technologies related to the use of metal single-crystal structures.

Author Contributions

Selivanov Viatcheslav is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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