Jarosław Komorowski Msc. Eng.
Institute of Materials Science and Engineering
Mechanical Faculty

Supervisor: Prof. dr hab. Eng. Piotr Kula

PhD project: The reversal of the direction of the front of crystallization in silicon on molybdenum substrate in reactive vacuum process.

Energy consuption on the world continues to grow together with industry development. The energy is mostly obtained from fossil fuels, which deposits constantly decreases. In the perspective of 120 years these fuels are going to be exhausted and it is inevitable that prices will continue to grow. Therefore many attempts are being made to obtain energy from renewable sources and replacing fossil fuels by renewed energy. Renewed energy sources can come from wind, water, biomass and biogas from the earth and also from the Sun. In this work was shown a method of refining silicon in order to later use it to build solar panels for solar energy conversion into electricity.

Currently, there are many methods for producing silicon suitable for later use in solar panels. The process for preparing silicon solar starts with the transformation of quartz SiO_2 contained in the sand for silicon with a purity of 99.5% in the metallurgical process. Then, in order to further purify of metallurgical grade silicon to a purity of more than 99.9999% Si two methods are used for silicon refining. The first one is the chemical and the second is metallurgical one. Chemical method is used in industry worldwide. However, it has disadvantages such as high costs due to high energy consuming and time consuming process of monocrystalline ingot manufacturing transformation in the later stages of the solar panels or even computer processors production. Another possibility is metallurgical method transformation silicon to silicon photovoltaic form on which research is conducted. There are known successful methods of refining silicon such as Kyropoulos, Bridgman, zone melting, washing in acid, the insertion of additives with a higher affinity for the contaminants present in the silicon and low pressure method.

The issue of the research project undertaken to prove the theoretical assumptions regarding the reversal front in the silicon melt crystallization with heated molybdenum surface resistance and a rectangular plaque in the process at reduced pressure and the receipt of silicon suitable for applications in the photovoltaic industry.

The main message is to reverse the crystallization front solidfied clean surface of silicon. These assumptions can be achieved by pusching contaminants present in the silicon substrate in the direction of the molybdenum in a forced directional crystallization initiated at the interface molten silicon-vacuum chamber atmosphere. The problem occurring when you try to focus the crystallization front moving in the direction of the substrate is much larger and faster heat dissipation through the lamina molybdenum acting for remelting silicon substrate than when the heat is dissipated through the atmosphere occurs in a vacuum chamber. My work assumes that the problem of movement of pollutants in the upper zone silicon solidfied can be solved by creating an appropriate undercooling on the surface of molten silicon which initiate homogeneous nucleation and growth allows embryos in the direction of the molybdenum substrate. In this way, expected to produce a directional crystallization front moving in the opposite direction than during spontaneous crystallization process of molten silicon on molybdenum substrate. An additional advantage of changes in the direction of movement of the crystallization front is the accumulation of dirt in front of crystallization, and pushing them toward the molybdenum substrate, leaving the melted surface layer of purified silicon suitable for PV.

The aim of my work is reverse the direction of movement of the crystallization front in silicon with a purity of 99.99% Si melted using the heating system which is heated resistance and molybdenum plates whose temperature can be controlled during the process, both during melting and crystallization. The hypothesis of the research project assumes that it is possible to achieve the above goals through a specially designed heating system consisting of molybdenum which is the bottom plates for melted silicon substrate and the upper lamina molybdenum serving to heat the raw material from the top as well as the special nozzles supplying cooling inert gas in place in which the molten silicon.

Komorowski