Editorial

Sunshine – the inherent attribute of summer. Summer is usually associated with relax, hiking, walks in the forest, sailing on the lakes, bike trips, rest on the seaside beaches. Summer reigns absolutely on the entire Northern Hemisphere in August, including the North America, Europe, and Northern Asia. The similar weather prevails nearly all the year round in the equatorial area, albeit in some seasons of the year the weather is rainy in spite of the high temperature. All of us, including the scientists, look forward for summer to begin, hope for the sunny and hot one, dream to stop the daily chores, take active rest and accumulate energy for the next busy year. The dream about acquiring energy does not pertain to holiday makers only. Acquiring the solar energy is the important activity of the contemporary professional power engineering. The Sun is the main energy source for the entire life on the Earth, delivering the steady and possible to anticipate stream of energy all the year round. of about 1.35 kW per each square metre of the planet's surface. The total solar energy radiation stream entering the Earth's atmosphere is about $2x10^{11}$MW, whereas the total power of all power stations in the World is nearly one hundred times smaller and does not exceed about $3x10^{6}$MW. Therefore, it is expected that the future of energy engineering is in solar power engineering. One of the ways to transform the solar energy into electrical one are the solar power stations in which, due to employment of energy concentrators, the solar energy density increase occurs, used to heating up the tank filled with the special oil, making it possible to obtain the superheated vapour used in the thermal power station, and this way does not differ from others in which the fuel used is the hard or brown coal. However, more and more used and currently the main method of converting the solar energy into the electrical one is photovoltaics. The photovoltaic effect occurs in some semiconductors and consists in generating a pair of current charge carriers electron-hole in the semiconductor by the solar radiation photons with the energy exceeding the gap of energy levels of this semiconductor. The photovoltaic effect was discovered in 1839 by E. Bequerel who fond out that illumination of the electrochemical battery electrode results in voltage increase on its terminals.

Solar radiation reaching the Earth's surface requires employment of semiconductors with the optimum energy levels gap of 1.4 eV to generate the photovoltaic effect without any undesirable losses. The photovoltaic effect occurs in silicon as one of the semiconductors. Therefore, all depends on the grey, hard, and brittle crystals or on the russet amorphous powder, as is such forms, depending on the acquisition method, this element is derived from the natural raw materials. Silicon is the second to oxygen element most widespread on the Earth. Its mass concentration in Earth's crust is about 26.95%. Silicon plays the primary role in the inanimate world, as the SiO_2 silica in its many polymorphic forms (quartz, trydimite, cristobalite) and such minerals as silicates and aluminosilicates feature the majority of rocks constituting the Earth's crust. Silicon was first separated by Jons Berzelius in 1822 from the SiO_2 silica considered as an element at that time, and only in 1942 the first cell based on the monocrystalline silicon was patented. In the 1950s the solar silicon cell was designed with the efficiency of 6% and the intensive research on mastering the photovoltaic cells technology ongoing since that time resulted in their efficiency exceeding 20% nowadays. It is possible to exploit only 44% of the solar radiation due to the energy levels gap characteristic of silicon, whereas the remaining part is dissipated converting, among others, to heat energy.

Because of the more than 90% portion of the currently used photovoltaic cells based on silicon panels in their overall number, silicon is the engineering material that plays the special role in the photovoltaic technology and development if its fabrication has an important meaning in the contemporary technology, albeit the photovoltaic cells can also be made from gallium arsenide, cadmium telluride, indium-copper selenide, and indium phosphide. The monocrystalline silicon has found widespread application in the photovoltaic cells manufacturing, albeit usually it is used as the base within which or on which the integrated circuits are fabricated and therefore it plays the fundamental role in electronics. Cells from the monocrystalline silicon have very good properties and high efficiency, albeit their manufacturing costs are relatively high. The photovoltaic cells fabricated from the polycrystalline silicon with lower efficiency are much less expensive because the lower energy consumption of their manufacturing processes and lower costs of the technological equipment. Further cost reduction may be possible in case of fabrication of the thin-film amorphous cell with thickness of 1–5 μm. The coefficient of reflection of electromagnetic radiation for the polished surface of the crystalline silicon is 35-50% depending on wave length. Texture (that is roughness, appearance or consistence of the surface or substance) obtained, among others, by laser treatment or the ARC antireflex coatings deposited with the CVD techniques can significantly reduce the coefficient of reflection of light from the cell surface.

The photovoltaic power stations have been developing very intensively, especially for the last years. The total power of the photovoltaic equipment installed in Europe is about 1,795 MW, which can be compared with the power demand of about 600,000 households. About 645 MW of solar cells were installed in Europe in 2005, which is 18% more than in 2004. The total turnover of the solar power energy industry rose 50% in 2005 to € 586 million. This growth could be even bigger if not for the global production limits and the continuous shortage of silicon as the main input material for this technology. The global silicon production was about 30,000 t in 2005. Additional 20,000 – 25,000 t of silicon were needed to satisfy the increased demand for the photovoltaic energy in 2006. This pressure on industry has forced the stronger innovative stance and analysis of new technologies, like, e.g., thin-film equipment, and improvement of the silicon management. The average thickness of the silicon panel fabricated with the conventional technology was 300 μm even in 2004, whereas in 2006 it decreased to 200 μm. The metallurgical silicon importance has grown in this time as the fabrication source of silicon used in photovoltaics. It is estimated that the power of 3,000 MW of the installed photovoltaic equipment planned by the European Union for 2010 will be exceeded twice, and some forecasts say that up to 2040 this technology may provide as much as 25% of the electrical energy in the world, and may reach even 50% at the end of this century. This is, clearly, the ambitious plan – but also a big challenge, perhaps for the scientific environment, including the materials engineering, and the business circles.

In USA photovoltaic arrays have been used mainly on a small scale, as rooftop panels to provide power for homes or commercial buildings, or to light roadside signs. Power plants were not the routine sources in USA to acquire the solar energy. At the end of 2007 the largest solar power plant in North America was set to work in Nellis Air Force Base in the Nevada desert outside Las Vegas in USA with the target power of 15 MW. Several European countries, particularly Germany, have built large-scale photovoltaic arrays that provide utility-scale power. In Germany the photovoltaic arrays were installed with power of 600 MW, which makes them the unquestionable leader in this area not only in Europe but also in the world. Spain is the second largest solar power European market, where there are 5,000 installations employing more than 10,500 people. In January 2008 the world's largest solar power installation Parque Solar Hoya de Los Vincentes, Jumilla in Murcia in Spain was set to work. This plant will reduce CO_2 emissions by 42,000 t and SO_2 emission by 9.2 t each year. Although currently the world's largest installation of its type anywhere in the world, this record will be, most probably, beaten shortly. Development of the world's biggest 40 MW photovoltaic power plant has already begun, which will be located in the townships of Brandis and Bennewitz to the east of Leipzig, in eastern Germany and will be finished by the end of 2009.

The subject area of fabrication, technology, and properties of silicon used in photovoltaics is; therefore, very developmental and because of that it is interesting for the Editorial Board and P.T. Readers of the Journal of Achievements in Materials and Manufacturing Engineering. We think that it will be of interest also for our P.T. Readers and their opinion is of the greatest importance to us. The paper opening this Issue pertains to the subject area of preparing the polycrystalline silicon (in photovoltaics called multicrystalline due to the significant grain size) for the photovoltaic applications. We invite you to read this and other papers published in this Issue.

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