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Technology and Costs

TECH 2018S10: Solar Grade Polysilicon

Solar Grade Polysilicon is one in a series of reports published as part of Nexant's 2018 Technoeconomics – Energy & Chemicals (TECH) program.

Overview

Polysilicon is a highly purified form of silicon and is widely used in the production of electronic chips, as well as solar photovoltaic cells, due to its semiconducting properties. In the solar sector, polysilicon is purified and casted into photovoltaic ingots, which are then sliced into wafers. Solar wafers are chemically processed into solar cells, which are packaged into solar power modules and distributed for installation onto grid systems to generate electricity from solar energy. Polysilicon is obtained by purifying metallurgical grade silicon feedstock to levels ranging from 99.9999999 percent silicon content (defined as 9N) to over 99.999999999 percent (11N). While the semiconductor industry was historically the main consumer of polysilicon, demand is now dominated by the solar energy sector, driven by sharp growth spurred largely by state level renewable energy incentives globally. Polysilicon production is dominated by the Chemical Vapor Deposition (CVD) process but alternative process technologies have been developed over the years, each with unique features as well as advantages. This TECH report provides an overview of the commercial and developing technologies for producing solar grade polysilicon and addresses:

- What are the major production technologies for polysilicon and how do they differ? Is the technology available and who are the key technology owners and licensors?
- What are the key developments in polysilicon process technologies?
- What is the market, business and regulatory environment like for polysilicon today?
- What are the key factors that impact overall economics for producing polysilicon across different geographic regions?

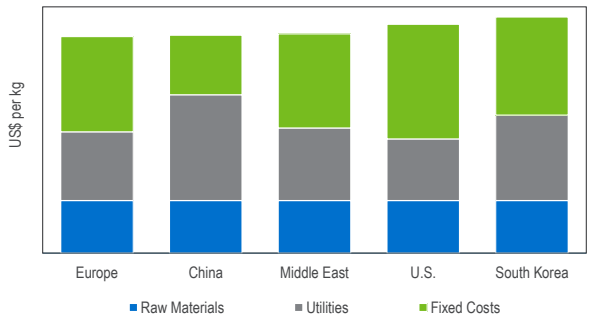
Commercial Technologies

The CVD process is currently the dominant production process for polysilicon, accounting for around 90 percent of global polysilicon capacity in 2017. This process was initially developed in the 1950s but has been modified and optimized for polysilicon purity and manufacturing cost advantages. Metallurgical grade silicon (usually containing 98 to 99 percent silicon purity content) is reacted with anhydrous hydrogen chloride to produce a mixture of silane compounds. The silanes are then purified into polysilicon via distillation and solidified through a deposition process. Deposition occurs in a batch reactor containing a base plate, bell jar and multiple silicon rods that are electrically heated where polysilicon deposits onto the rod and reaction stops when the rods reach a predetermined diameter. An overview and development of available commercial technologies is provided in the report, with particular focus on key producers and technology providers such as Wacker Chemie AG, GT Advanced Technologies as well as Hemlock Semiconductor Corporation, amongst others.

Process Economics

Detailed cost of production estimates for the CVD process are presented for USGC, Middle East, China, Europe and South Korea, reflecting the location of existing polysilicon capacities. An economic comparison against alternative technology is also included in the report.

Polysilicon Regional Cash Cost Production



Commercial Overview

Global polysilicon consumption in 2017 reached 427 thousand tons, almost double the consumption back in 2010. Demand is driven by its main use as a key material for the production of solar modules, which has expanded rapidly. Going forward, average annual demand for polysilicon is expected to grow at almost eight percent through 2021. An overview of the supply, demand, and trade of polysilicon on a global and regional (North America, Europe and Asia Pacific) basis is provided in this TECH report.

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- Process economics – comparative costs of production estimates for different technologies across various geographic regions
- Overview of product applications and markets for new as well as established products
- Regional supply and demand balances for product, including capacity tables of plants in each region
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Technology and Costs comprises the Technoeconomics – Energy & Chemicals (TECH) program (formerly known as PERP), the Biorenewable Insights program (BI), the Sector Technology Analysis, and the new Cost Curve Analysis. These programs provide comparative economics of different process routes and technologies in various geographic regions.

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