Technology Basis for Enhanced Competitiveness of

Mono-Crystalline Silicon Wafers

单晶硅片竞争力提升的技术基础

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In recent years, PV wafer market has experienced significant change and mono-crystalline silicon wafers have been continuously gaining market share from multi-crystalline wafers. The driving force behind the increased competitiveness of mono-crystalline wafers is the technology progress of related production equipment which resulted in rapid cost reduction. In this report, the recent technical progress in wafer production equipment is discussed. The cost ingredients of wafer production are analyzed in detail. It is shown that with the newest equipment and process technology the non-silicon cost per-wafer can be reduced to less than 0.1 USD. The cost reduction is mainly due to highly efficient crystal growers, newer generation of diamond wire wafer saws, and automation in wafer producing process. Since 2015, the market share of mono-crystalline wafers has been steadily increasing, from about 19% of 2015 to about 65% this year, and is expected to further grow to around 85% in 2021. With the analysis it is also shown that in order to be competitive against mono-crystalline wafers, other wafer technologies not only need to further reduce their cost, but more importantly also need to enhance their PV conversion efficiency.

近几年来光伏硅片市场经历了显著的变化，单晶硅片不断从多晶硅片那里夺取市场份额。单晶硅片竞争力提升背后的驱动力是相关生产设备的技术进步导致成本快速降低。本报告中讨论了近期硅片生产设备的技术进步，详细分析了硅片生产的成本组成。分析表明，运用最新的设备和工艺技术每个硅片的非硅成本可降至0.1美元以下。成本的降低主要是由于采用高效长晶炉、新一代金刚线切片机、以及硅片生产过程的自动化。单晶硅片的市场份额自从2015年以来稳定增长，从2015年的19%增长至今年的65%，预计2021年将继续增长至约85%。通过分析也指出其他硅片技术如果想要具备针对单晶硅片的竞争力，不仅仅需要进一步降低其成本，更重要的是需要提升其光伏转换效率。

About the Author:

Dr. Zhixin Li is the CEO of Dalian Linton NC Machine Co. Ltd. (Linton Machine), and President & CTO of Linton Crystal Technologies located in Rochester NY, USA. Linton Machine is a leading manufacturer of solar and semiconductor equipment. Its products include diamond-wire wafer saws, mono-crystal growing furnaces, multi-wire squaring machines, automatic silicon ingot grinders, automatic wafer separators, wafer cleaners, and other silicon wafer production machines.

Prior to working for Linton Machine, Dr. Li hold positions at JYT Corporation (as President & COO) and Ferrotec USA Corporation (as General Manager, Director of Technology, etc.).

Dr. Li received his Ph.D. degree from the Department of Mechanical Engineering, Massachusetts Institute of Technology in April 1990. In 1984, he received his MSME degree from Xian Jiaotong University. Between 1977 and 1981 he studied in Shandong Engineering Institute (currently the School of Engineering, Shandong University) and received his BSME degree.

作者简介：

黎志欣博士现任大连连城数控机器股份有限公司总经理, 美国连城晶体技术公司总裁兼首席技术官。连城数控是太阳能及半导体设备行业的领先制造企业，主要产品包括金刚线切片机、单晶炉、多线切方机、全自动硅锭磨床、自动插片机、硅片清洗机及其他硅片生产设备。

来到连城数控之前，黎博士曾在京运通任总裁兼首席运营官，也曾在Ferrotec USA Corporation 任职 General Manager 和技术总监等职位。

1990年毕业于美国麻省理工学院，获机械工程系博士学位。1984年获西安交通大学硕士学位。1977年至1981年间在山东工学院（现山东大学工学院）第二机械工程系学习并获学士学位。