【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅱ)

Title of Project : Next generation mesoplasma SIEMENS technology for direct production of wafer - equivalent thin film solar cells

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Research Area : Material Science

Keyword : Plasma processing, solar cell

【Purpose and Background of the Research】

Recent global concerns on the energy and environmental issues have urged production of high performance solar cells. This has readily spurred rapid development of high quality Si production route from innovative standpoints. Siemens method has been a major and established technology for high pure Si production. However, its production yield is in principle limited as small as 30% and it even requires substantial electricity for its long heating process. Several approaches have been proposed to improve the yield based primarily on an increase in reaction interface. Yet, more radical process to surpass the efficiency is longed from the innovative conception.

Meanwhile, we have identified a novel process with mesoplasma that provides unique plasma environment with reduced ion and thermal damages at high transport of reaction species on plasma flow. These characteristics seemingly fit well to the requirements for giant-electronics. This plasma is also anticipated to provide high atomic hydrogen flux that readily promotes reduction of trichlorosilane (TCS) to Si, while suppressing formation of sililcon tetrachloride.

In view of these circumstances, with an aim to develop novel production route of wafer - equivalent Si thin films solar cells, the project will focus on an enhancement of TCS reduction and a direct deposition of high quality Si thin films from TCS under mesoplasma condition.

【Research Methods】

The core technologies for the next generation mesoplasma Siemens (MP-Siemens) will be the effective use of atomic hydrogen for high efficient reduction of TCS and high rate direct deposition of high quality Si films, based firmly on understanding the mesoplasma flow and plasma/substrate interaction. The stepwise research tasks are thus set; 1) basic design of mesoplasma CVD reactor, 2) mesoplasma flow control, 3) quality and throughput improvement with dynamic process control, and 4) integration as MP-Siemens. These will be implemented from the material processing perspectives.

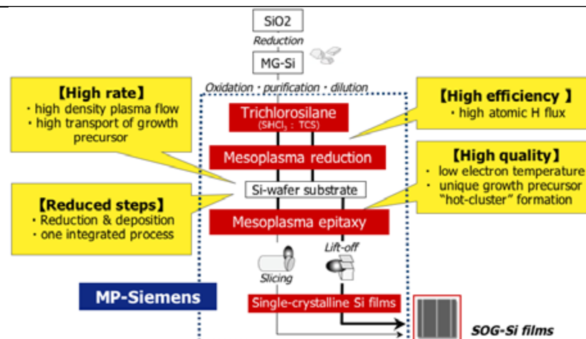

Figure Conceptional flow of the project

【Expected Research Achievements and Scientific Significance】

Polycrystalline Si film deposition at 1000 nm/sec and epitaxial Si film growth at 70 nm/sec have been already demonstrated with monosilane in the preceding project. High flux of atomic hydrogen by several orders of magnitude than the low pressure processing is readily anticipated in the mesoplasma environment. One can thus foresee the wafer - equivalent quality thin film deposition from TCS. The consequent direct production of solar cells, which bypasses several steps, should have significant impact on the relevant industries.

【Publications Relevant to the Project】

・ J.M.A. Diaz, M. Kambara, T. Yoshida, Detection of nanoclusters by x-ray scattering during silicon film deposition by mesoplasma chemical vapor deposition, J. Appl. Phys., 201 (2008) 013536-5.
・ J.M.A. Diaz, M. Sawayanagi, M. Kambara, and T. Yoshida, Electrical properties of thick epitaxial silicon films deposited at high rates and low temperatures by mesoplasma chemical vapor deposition, Jpn. J. Appl. Phys., 46(8A), (2007) 5315-5317.

【Term of Project】 FY2009 - 2012

【Budget Allocation】 124,000 Thousand Yen

【Homepage Address and Other Contact Information】
http:// www.plasma.t.u-tokyo.ac.jp/