Plasma diagnostics as a tool for process optimization: the case of microcrystalline silicon deposition

B. Strahm*, A.A. Howling and Ch. Hollenstein

Ecole Polytechnique Fédérale de Lausanne (EPFL), Centre de Recherches en Physique des Plasmas, CH-1015 Lausanne, Switzerland.

Microcrystalline silicon thin films are of great interest for the fast growing market of thin film photovoltaic (PV) solar cells. PV products nowadays commercially available are based on amorphous silicon thin film which shows poor stability compared to microcrystalline silicon PV cells that are not affected by light induced degradation. However, plasma deposition of microcrystalline silicon is not yet well understood and the large number of process parameters adds further difficulties to optimize plasma process.

An analytical plasma chemistry model has been used to explain the link between the plasma composition and the deposited film crystallinity [1]. It shows that a high atomic hydrogen flux to the surface of the growing film with respect to the flux of silane radicals is necessary to grow crystalline material and that this ratio is directly related to the plasma composition, i.e. the silane concentration *in the plasma*. This model is in excellent agreement with plasma composition measurements performed by time-resolved optical emission spectroscopy and infrared absorption in the exhaust flow of a large area plasma reactor coupled with thin film characterisation such as Raman spectroscopy. This acquired knowledge has been used to develop a reactor-independent optimization strategy in order to improve both the deposition rate and the gas utilization efficiency, making possible a cost-effective plasma production of PV solar cells based on microcrystalline silicon thin film.

References

[1] B. Strahm, A.A. Howling, L. Sansonnens and Ch. Hollenstein, Plasma Sources Sci. Technol. **16**, 80-89 (2007)

*E-mail address: benjamin.strahm@epfl.ch