Live session of seminar series **Focus Materialchemie** – Wednesday, **05.04.2023** **11:00** – **@ Seminarraum Lehar 01** (TU-Wien, Getreidemarkt 9, BC, OG. 01, room A46) **–** **ZOOM** (ID: 983 0066 2349)

Recent developments in applications of plasma to the manufacture of flexible solar cells

Tomáš Homola[a,b]

tomas.homola@mail.muni.cz

[a]*Department of Physical Electronics, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic*

[b]*Roplass s.r.o., Masarykova 118, 664 42 Modřice, Czech Republic*

The current manufacture of modern energy-harvesting systems and other electronics based on silicon does not meet the requirements of the steps involved in low-cost fabrication. Rapid and low-cost roll-to-roll manufacture – the future of commercialization for flexible and printed electronics – requires flexible and low-cost substrates such as PET, PEN and, more recently, green materials such as nano-paper as well. The temperature at every single fabrication step is crucial with such materials and cannot exceed a certain threshold, generally 150 °C or less. Low-temperature plasma can, therefore, provide an excellent way forward for future manufacturing methods.

We present a proprietary, large-area plasma of extremely high-volume power density, up to 100 W.cm^{-3}, capable of generating diffuse, homogeneous and cold plasma (<70 °C) in the open air, as well as in other technical-grade gases including nitrogen, argon, methane, hydrogen, carbon dioxide and pure water vapour (Fig. 1). Although the temperature of the plasma is very low, the population of energetic states is sufficient to induce physical/chemical changes on the surfaces of a range of nanostructured materials and semiconductors, such as graphene oxide, titanium dioxide, perovskites, and others, resulting in various crystallinity, optoelectronic and wettability changes, depending on the gas employed for plasma generation. The low temperature of the plasma and rapid treatment times, in the order of 1–10 s, enables the integration of plasma processing into roll-to-roll manufacture, a significant step forward in the further commercial success within the emerging field of flexible and printed electronics.

In this contribution, we present two examples of fast (< 1 min) low-temperature plasma processing of thin films in perovskite solar cells: (i) plasma treatment of indium-tin-oxide electrodes as a replacement of time-consuming chemical treatment before deposition of conductive films, and (ii) plasma treatment of mesoporous titanium dioxide electron transporting layers as a replacement of time-consuming and high-temperature sintering.

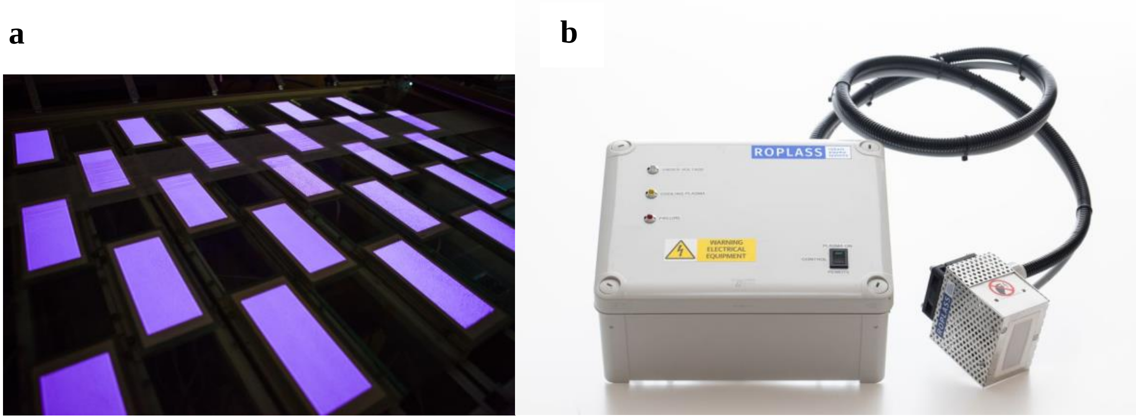

Figure 1. a) 25 plasma units (plasma area of each unit = 8 cm × 19 cm) operating in roll-to-roll setup under ambient air, b) commercial „RPS40+“ portable plasma unit (5 cm × 2 cm).