Self-Cleaning Composite Thin Films Based on Metallic Oxides and Reduced Graphene Oxide for PV Glazing

Maria Covei*, **Cristina Bogatu, Dana Perniu, Anca Duta, Ion Visa**
R&D Center Renewable Energy System and Recycling, Transilvania University of Brasov,
29 Eroilor Street, 500036, Brasov, Romania
*maria.covei@unitbv.ro

Some of the areas of applications of self-cleaning coatings (SCC) include the built environment (fenestration, walls, roofing), the automotive industry (rear-view mirrors, windshields) and everyday use (glasses, clothing), by preventing dust accumulation and water vapour condensation. As coatings on photovoltaic (PV) modules, SCC could decrease fouling and lead to improved power output. With some degradation due to weathering, re-application of the films on the PV glazing can be considered an in-field solution to prolong the overall PV life-time.

To prevent or diminish fouling by organic pollutants, SSC should be able to degrade these molecules, ideally under solar radiation, and wash away the by-products. For this, high photocatalytic efficiency and very low contact angle are both requirements of the thin films. The most common materials investigated as SSC are metallic oxides, which are generally wide band gap semiconductors and are only activated under UV radiation. To extend the activation energy spectrum to the VIS domain and to decrease cost, a common option is the coupling of wide band gap and narrow-band semiconductors.

In this work, composite thin films based on TiO_2, WO_3 (as the wide band gap metallic semiconductor oxides) and rGO (as the narrow band gap semiconductor) were deposited on solar glass and PV glazing to test their efficiency as SCC, as well as their durability under controlled irradiance (G=300..1000 W/m^2), humidity (10..100%) and temperature (-20..40^oC). Current-voltage measurements were recorded for the PV modules before and after testing and were used to calculate the power output variations.

The thin films were obtained by spraying a stable dispersion of TiO_2-WO_3-rGO sol-gel powder (50:50:1 gravimetric ratio) mixed with water-ethanol (3:1 volumetric ratio) and stabilized with different anionic, cationic or polymeric compounds. The thin film thickness was optimized to permit high film transmittance (T>80%) so that light penetration to the PV cell is not hindered, low contact angle ($\theta<10^o$) to allow very good surface wetting under high humidity and good photocatalytic efficiency ($\eta>80\%$) in the degradation of methylene blue and phenol under UV-VIS radiation (at high irradiance). Testing showed that while the SCC met all these criteria, durability under extreme conditions was faulty (film washout could be detected) making re-application of the films necessary.