Suitability of functional DLC coatings onto thin polymers for food packaging

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Functional diamond-like carbon (DLC) films (a-C:H: a-C:H:Si, a-C:H:N, ta-C:N) were deposited on polyethylene terepthalate (PET), polycarbonate (PC) and polytetrafluoroethylene (PTFE) substrates (thickness 100-500 micron) using radio frequency plasma-enhanced chemical vapour deposition (PECVD) method. We aim to highlight the optimum deposition conditions for improved gas (O_2, CO_2, etc) barrier performance of these coating. The XPS, Raman, surface profilometry, SEM and gas permeation analysis were used to analyse the microstructure and properties of the coatings. The influence of the substrate bias, film thickness, N_2 plasma pre-treatment and process pressure on the gas barrier property were reported. The hydrogen content in the coatings plays a major role in modifying their gas barrier performance. However, these hydrogen rich polymeric coatings will suffer from low hardness and weaker scratch resistance. Therefore, we have incorporated a nitrogen doping strategy to release the stress in these coatings without affecting their mechanical properties. The a-C:H:Si and a-C:H:N (with approximately 5 at % N) coatings revealed best gas barrier value of around 30 cc/m^2/day/bar. Our results showed clear improvements in gas barrier properties in all of the DLC coatings in comparison to the pristine polymer substrate. It is our view that our results on thin polymer substrates are significant particularly for food packaging applications.