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INNOVATIVE USES OF POLYDOPAMINE (PDA) IN THE FIELD OF (BIO)ANALYTICAL CHEMISTRY

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The history of dopamine (DA) investigation starts at the beginning of the 20th century with the chemical synthesis [1]. Later on, DA was identified in human body, together with the discovery of multiple functions as monomer or polymer [2,3]. The description of the DA metabolism in the brain and peripheral areas allowed the explanation of age-related synthetic decline [4], the recognition of pathologies associated with concentration anomalies of DA and subsequent associated-drugs application in several medical conditions [5]. Finally, there was the reawakening of synthetic dopamine at the beginning of the 21st century [6-8], when the non-enzymatic oxidation to *ortho*-quinone and the subsequent self-polymerization has generated several applications in medicine, (bio)analytical chemistry, and materials science [9-14]. The huge significance of endogenous Dopamine (DA) and the severe clinical conditions associated with DA concentration anomalies, including Schizophrenia, and Parkinson's disease, has generated more than 200 thousand scientific papers over the past 80 years. A more recent and intriguing outcome from this plethora of information is represented by the electrochemical and chemical reaction pathway for polydopamine (PDA) formation in aqueous solutions that requires the synthesis of 5,6-indolequinone (IQ) monomer from dopamine molecule [4,15]. Notably, the polymer growth is inhibited by low pH (below 4) and high-concentration of various electrolytes that impair the preliminary intramolecular cyclization of oxidized dopamine by decreasing the nitrogen nucleophilicity [6]. Since the pioneering investigations and application on dopamine polymerization by electrodeposition [6,7], and then by O_2/pH-induced oxidation [8], thousands of papers involving the PDA synthesis, study and application have been published. Notably, the last four years represent almost 80% of all the scientific production, underlining the enhanced interest arising from the versatile chemistry of this endogenous catecholamine and its complex polymerization mechanism. The redox potential of catechol moiety has been exploited to produce optically and catalytically active metal nanoparticles in situ. This feature responsible for the cross-linking of dopamine can be enhanced by chemical oxidants, UV, or microwave irradiation, influencing the coating of PDA at nanometric scale employed for a variety of physical, chemical and biological studies. However, this field of research is still young and challenging in application of PDA-coated surface to medicine, energy and industrial manufacturing, for example. In particular, a promising field of PDA research is the surface coating for molecular sensing and affinity separation for pharmaceutical studies and clinical applications, following the peculiar physicochemical properties of PDA, and the molecular immobilization and imprinting capability of this biopolymer. Here we report a survey of this demanding area of bioanalytical research, focusing on the state-of-art of PDA

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applications for coating and imprinting, and offering a long-term vision for the capability of this polymer to be exploited to its full potential.

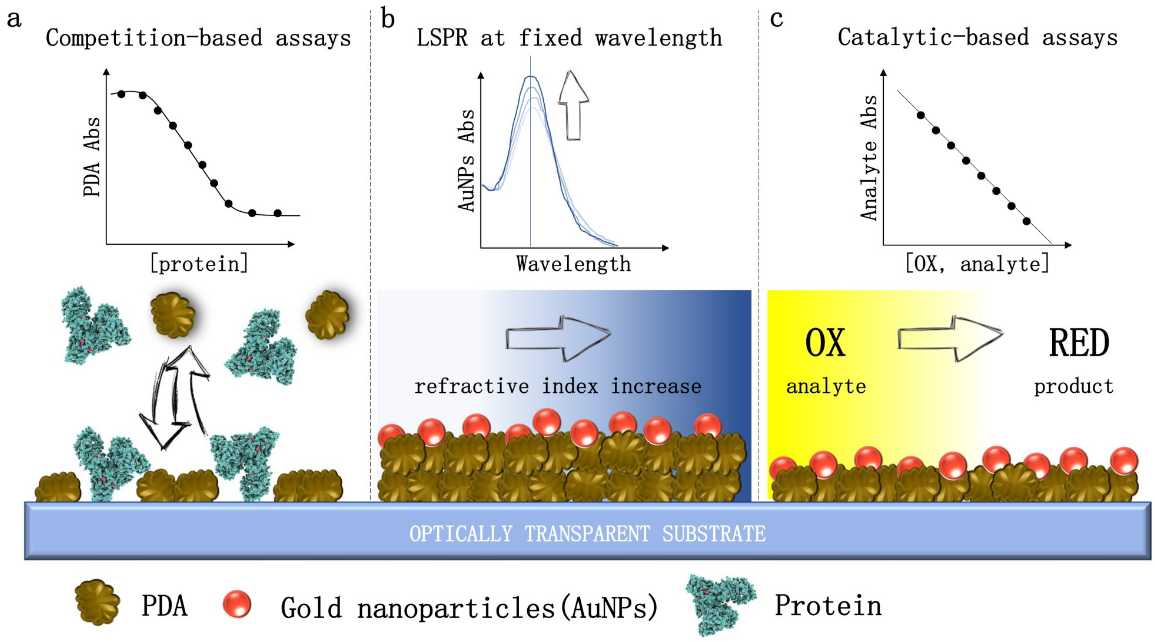

Figure 1. Innovative uses of PDA in the field of (bio)analytical chemistry. (a) Competition-based assay for quantification of total protein in biological fluids. (b) (LSPR)-based quantitative assay at fixed wavelength for applications in clinical, food, and environmental controls. (c) Catalytic-based assay for redox reactions. From reference [13].

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