Implementing paper-based analytical devices in chemistry laboratory experiments for high school students

µPADs associated with colorimetric detection have attractive features in chemistry due to their small size and portability. These devices have become popular for demonstrating experiments or teaching analytical chemistry for high school students. This study describes the construction of µPADs through stencil printing or wax printing techniques to teach redox reactions, acid-base and precipitation titrations using distance-based measurements. For stencil printing, the layout with a circular zone and two detection zones connected by two microfluidic channels were drawn in Corel Draw. A paper substrate was laminated with a press and a layer of vinyl adhesive was added to it. The paper was cut by a paper cutter and adhesive edges were removed. For proof-of-concept, a redox reaction with sodium hypochlorite (colorless) and N-N diethyl p phenylenediamine(red) generates a purple product. For acid base and precipitation titrations, the devices were wax-printed on paper in a layout with a circular zone connected to a rectangular channel. To perform acid base titrations, the channel was filled with a 0.05 mol L^{-1} NaOH solution with phenolphthalein. Then 4.5 µL of acetylsalicylic acid were added to the circular zone. The length of the discolored zone was measured with a digital caliper. An analytical curve with R^2 = 0.9949 from 5.0 to 16.4 mm when the concentration varied from 0.005 to 0.05 mol/L. For chloride precipitation titration, $AgNO_3$ and K_2CrO_4 were by applying 10 uL of a 0.1 mol/L silver nitrate solution to the zone. 10 uL of potassium chromate was applied to the zone, producing a brick-red Ag_2CrO_4.10 uL of NaCl was applied to the zone. NaCl reacts with silver chromate (brick-red color) to form AgCl (white precipitate). An analytical curve with R^2 = 0.9854 was obtained. It was possible to detect chloride in real samples of different brands of saline solution and olive brine and corn preserve with satisfactory results.