Representative Publications on Statistics, QC/QA, and DOE

A one-page selection of peer-reviewed publications
(Selected from 2005 to 2011)

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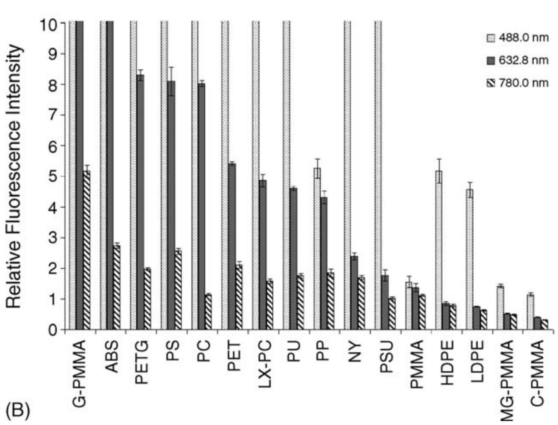
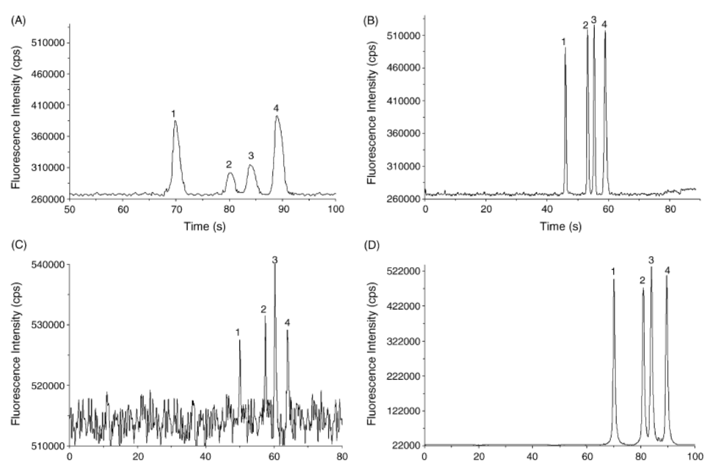
Physiochemical properties of various polymer substrates for use in manufacturing disposable plastic microchips for bioanalytical and pharmaceutical applications

Role: First Author Status: Published (Journal of Chromatography A, 1111: 238-251, 2006)

A suite of polymers were evaluated for their suitability as viable substrate materials for microchip electrophoresis applications, which were fabricated via replication technology. The relevant physiochemical properties investigated included the glass transition temperature (Tg), UV–vis absorption properties, autofluorescence levels, electroosmotic flow (EOF) and hydrophobicity/hydrophilicity as determined by sessile water contact angle measurements. These physiochemical properties were used as a guide to select the proper substrate material for the intended microchip electrophoretic application. The T_g of these polymers provided a guide for optimizing embossing parameters to minimize replication errors (REs), which were evaluated from surface profilometer traces. RE values ranged from 0.4 to 13.6% for the polymers polycarbonate (PC) and low-density polyethylene (LDPE), respectively. The absorption spectra and autofluorescence levels of the polymers were also measured at several different wavelengths. In terms of optical clarity (low absorption losses and small autofluorescence levels), poly(methyl methacrylate), PMMA (clear acrylic), provided ideal characteristics with autofluorescence levels comparable to glass at excitation wavelengths that ranged from 488–780 nm. Contact angle measurements showed a maximum (i.e., high degree of hydrophobicity) for polypropylene (PP), with an average contact angle of $104^{\circ} \pm 3^{\circ}$ and a minimum exhibited by gray acrylic, G-PMMA, with an average contact angle of $27^{\circ} \pm 2^{\circ}$. The EOF was also measured for thermally assembled chips both before and after treatment with bovine serum albumin (BSA). The electrophoretic separation of a mixture of dye-labeled proteins including; carbonic anhydrase, phosphorylase B, β-galactosidase, and myosin, was performed on four different polymer microchips using laser-induced fluorescence (LIF) excitation at 632.8 nm. A maximum average resolution of 5.04 for several peak pairs was found with an efficiency of 6.68×10^4 plates for myosin obtained using a BSA-treated PETG microchip.



LIF background levels measured at three different excitation wavelengths, 488 nm, 632.8 nm, or 780 nm. The LIF system was configured in an epi-illumination format. In all cases, ~2 mW of average laser power was used at the polymer surface. The collected photons were filtered using an interference filter that possessed a center wavelength red-shifted by ~30 nm from the excitation wavelength with a half-band width of ~10 nm. The average fluorescence intensity (cps) of the polymers was normalized with respect to the value obtained for glass at the same excitation wavelength.

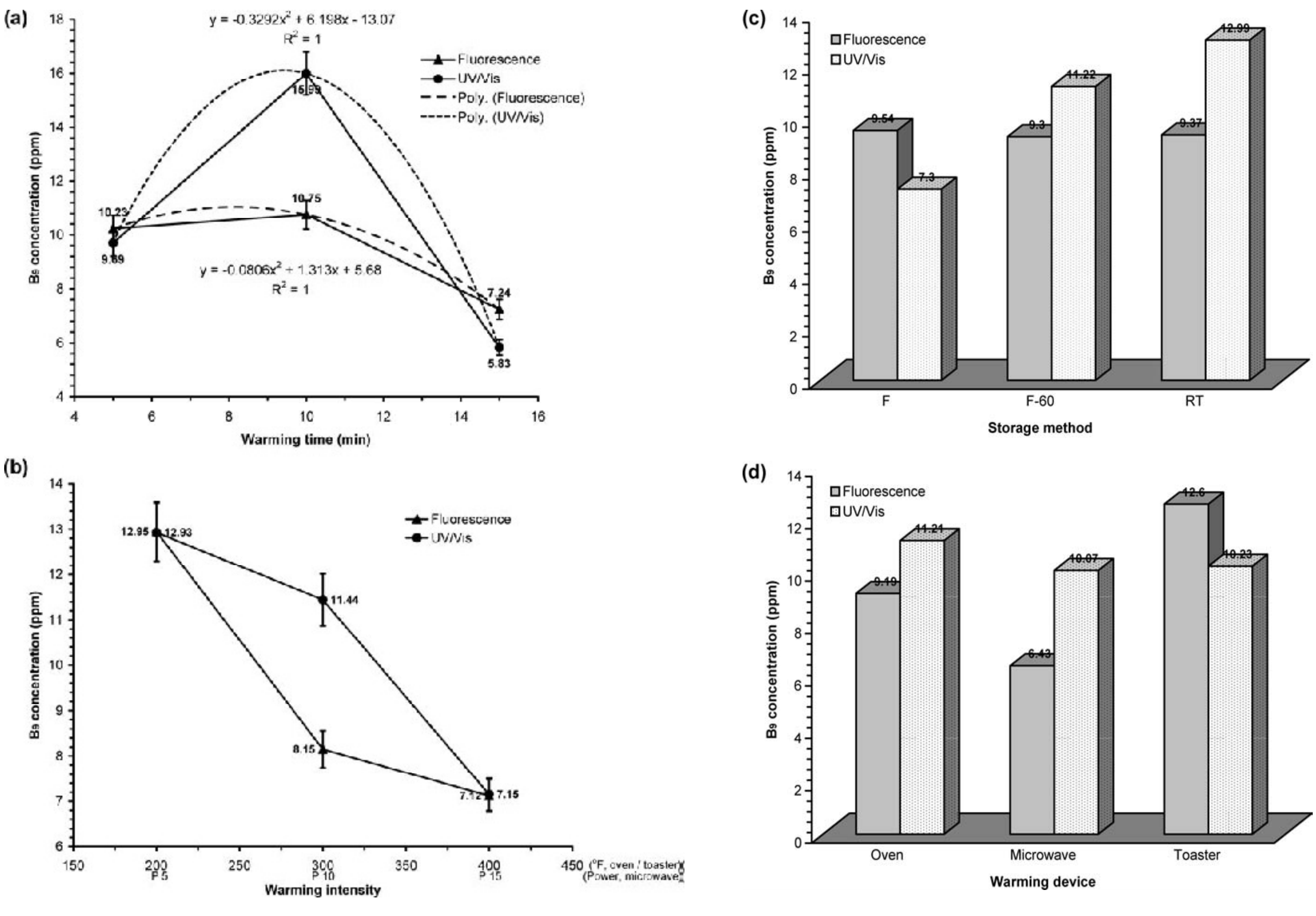


Electrophoretic separation of several proteins in polymer microchips: (A) Native PP; (B) BSA-treated PP; (C) BSA-treated PETG; and (D) BSA-treated C-PMMA. All separations were performed with a running buffer consisting of 100 _M Tris–HCl, 1% SDS, pH 9.2; E = 300 V/cm; Leff = 30 mm; LIF detection (excitation = 632.8 nm; ~2 mW average power). The electrophoretic peaks are identified as: (1) carbonic anhydrase; (2) phosphorylase B; (3) β-galactosidase; and (4) myosin. In all cases, the concentration of the proteins used for the electrophoresis was 300 nM.

The use of modern design of experiments (DOE), statistics (ANOVA) and optimization methods in research, R&D, quality control, process design, and product development

Role: First and Corresponding Author Status: Published (Nutrition and Food Science, 37: 105-114, 2007)

In this study, warming intensity, warming time, warming device, and bread storage method were selected as the most effective factors on B_9 loss in bread. The variation of B_9 in bread and its loss were studied with orthogonal array design (OAD) using the L_9 optimization matrix. With a calculated per cent of contribution (P%) of error of 0.38 percent and according to the analysis of variance, ANOVA, of the fluorescence data, 86 percent of B_9 was saved by using toaster as the warming device, a bread warming temperature of <200^{o}F and a warming time of <10 min. Fluorescence method evaluated warming intensity and warming device as the most powerful factors affecting the B_9 concentration in bread with corresponding P% of 42.3 percent and 41.7 percent, respectively. In conclusion, heat destroyed significant portion of B_9 in bread during daily warming protocols, and the suggested optimized parameters obtained in this work significantly minimized this loss. The OAD can be used to effectively evaluate effective parameters on food science investigations.



Effects on B_9 concentration in bread plotted vs. (a) warming time; (b) warming intensity; (c) bread storage method; and (d) warming device.

Other related publication: Shadpour, et al, *Journal of Materials Science: Materials in Electronics,* 13 (2002) 139-148.