Wilhelmy Balance Measurement of Absorbing Surfaces: Applications to Inkjet Receptors

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**Abstract**

We have used the Wilhelmy balance technique to examine the surface thermodynamics of absorbing wettable materials. Surface energetics of water soluble polymers were measured, as well as the addition of surfactants to these polymers. Interesting hysteresis effects were observed with some test liquids and various samples. Discussion and a possible interpretation of these results will be presented.

**Introduction**

The Wilhelmy balance, or as it is alternatively called, dynamic contact angle analysis, is used in characterizing the wetting behavior of polymeric materials, composites, fibers, metals, and ceramics. Advancing and receding contact angles are obtained with this apparatus. Characterization of a surface can be made continuously during hydration. Wetting behavior can be measured and correlated to surface composition and surface treatment. In this paper, we will consider the effects of wettability of some water soluble materials used in experimental inkjet receptors.

**Experimental**

The Wilhelmy balance used in these studies was manufactured by Cahn Instruments, Inc., Cerritos, CA. We used standard instrumental settings to do the experiments including computer data collection and storage. The rate of the test plate into the solution was 0.14 mm/second. Experiments were carried out at ambient room temperature (22°C). We used high purity liquids as test liquids for these experiments. To determine surface energetics more accurately, one uses a set of liquids ranging from nonpolar to polar. We chose n-hexadecane (Aldrich, MW= 30,000-50,000) and hydroxyethylcellulose (Aldrich). Some experiments also used the addition of a surfactant such as the non-ionic surfactants from 3M such as FC-170c. These materials were used as received. Solutions were made by dissolving the polymer in DI water at room temperature for 24 hours, then adding the surfactant to the level desired. Polyvinyl alcohol concentrations of 5% by weight of the total solution, while hydroxyethylcellulose was used at less than 2% of the total solution weight. Surfactant weights of up to 10% with respect to polymer weights were studied.

**Results**

The output from an individual Wilhelmy experiment is a plot of force (mg) vs. distance (mm). Typical Wilhelmy data will be shown at this talk. The data taken for the polymeric samples only look to be fairly typical, regardless of the test liquid used. For samples containing certain non-ionic surfactants, at concentrations greater than 1%, Wilhelmy data that was unusual was observed. This was true for the cases where polar solvents (especially water) were used. Marked oscillations in the advancing contact angle data are present, as well as a large difference between advancing and receding traces.

Nonpolar test liquids (n-hexadecane) show much less discrepancy between samples, other than slopes of the traces that give rise to the contact angles actually measured. This appears to be true regardless of the amount or chemical composition of the surfactant. Other results will be tabulated and presented in this talk.

**Discussion**

The unusual hysteresis effects measured in these experiments are indicative of a strong interfacial effect between the polar liquid and the top layer of the coated material. That the effect of the surfactant to increase the surface energy of the solid surface, and also change the hysteresis behavior is somewhat unexpected. Possible interpretations of this behavior will be discussed. Other experimental methods to examine the surface will also be presented.

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**Recent Progress in Ink Jet Technologies II**

**Chapter 6, Materials and Media**