

Contact Angle Measurements on Aircraft Coatings

May 15, 2000

Contact angles using water were measured on five coatings used on aircraft. These coatings are very uniform spatially but do exhibit hydration, meaning their contact angle changes as a function of exposure to the vapor of the test fluid (i.e., water). Therefore each contact angle was measured as a function of time, with $t = 0$ corresponding to the first contact of the water with the dry surface. Two contact angles can be identified: an initial angle and a steady-state angle. These surfaces equilibrated in about 15 seconds, as can be seen from the representative graphs of contact angle versus time presented below.

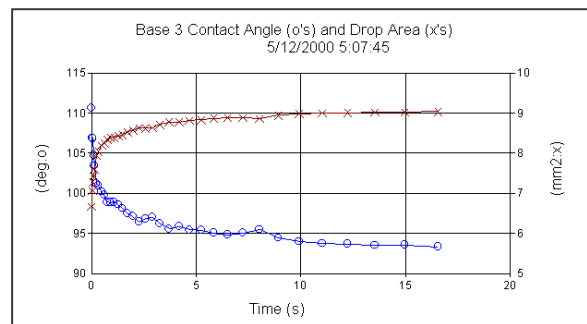
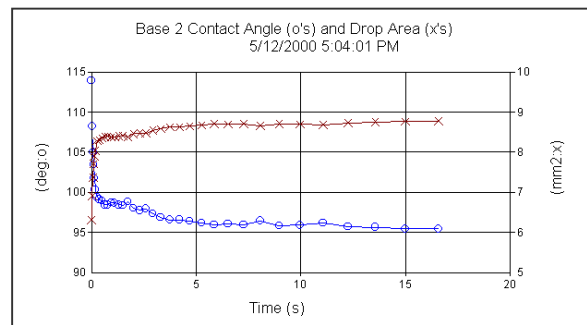
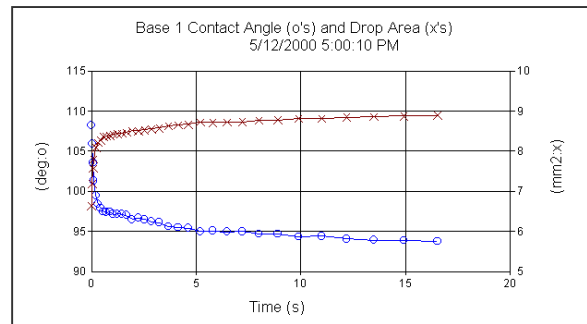
Hydration is not unusual, appearing on anodized aluminum and plasma treated polymer surfaces, to give two examples. A surface energy can be associated with either the initial or steady-state (equilibrated) contact angle, although the latter is probably more useful in describing a surface exposed to rain and snow. Surface energies were computed with a modified Girifalco-Good-Fowkes-Young model; this is a single fluid model but one which uses the contact angle of water on Teflon as an additional calibration point to achieve better correspondence at high contact angles (which these are) to other models (say to the Owens-Wendt or Lewis acid/base models).

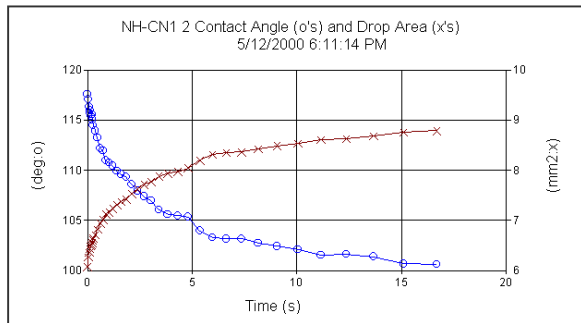
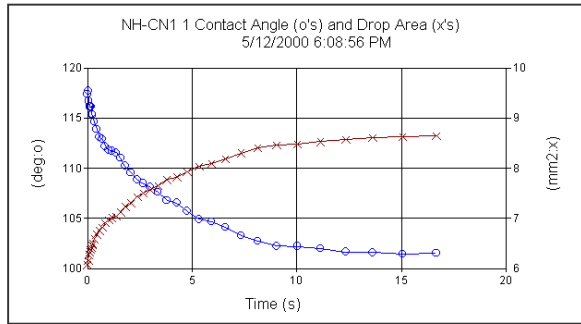
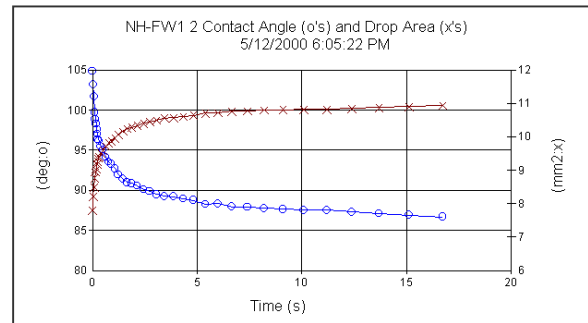
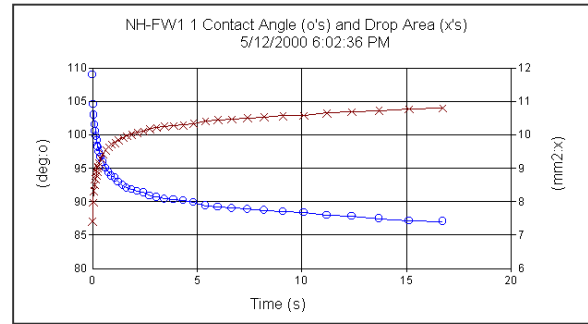
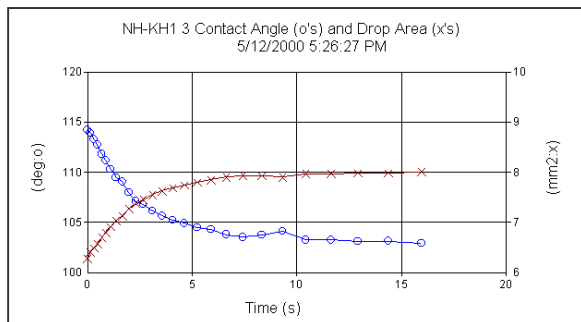
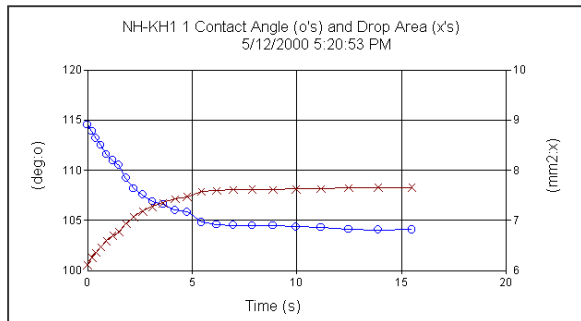
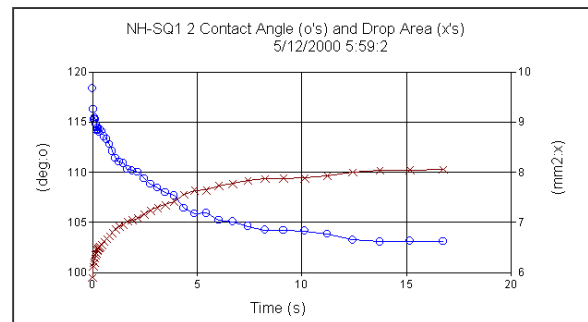
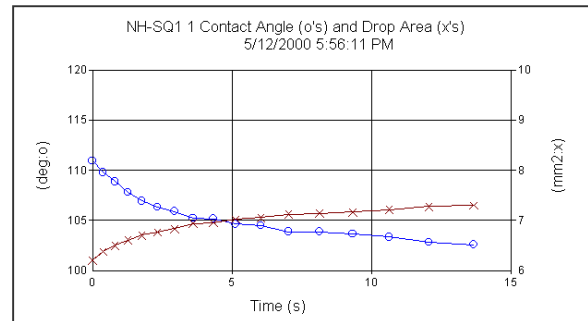
Two surfaces were measured with 5 independent drops and the other three were measured with two drops. No significant variations were found within any single surface, so the number of drops was reduced on the latter surfaces measured. Drops were

always placed at least 10mm apart and never closer than 10mm to an edge.

The water was checked for surface tension and measured 71.2, within 0.75mN/m of theoretical value of 71.95mN/m at 25°C, the ambient temperature. This is close to the measurement uncertainty, so the test fluid may be considered valid.

Sample 1.



Sample 2.**Sample 4.****Sample 3.****Sample 5.**

Summary of Contact Angle Values and Surface Energies

All contact angles and surface energies are for the average of the measured values. "Final" contact angle means steady-state or equilibrium value.

Sample	Initial Contact Angle (°)	Final Contact Angle (°)	Initial Surface Energy (mN/m)	Final Surface Energy (mN/m)
Base	110	95	19.0	27.4
NH-KH1	115	103	16.5	22.8
NH-CN1	118	101	15.1	23.9
NH-FW1	107	87	20.6	32.3
NH-SQ1	115	103	16.5	22.8