Anal. Calcd. for $C_5H_6O_3$: C, 52.63; H, 5.30. Found: C, 52.25, 52.18; H, 5.31, 5.39.

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RECEIVED APRIL 8, 1949

Some Substituted Benzalmalononitriles[1]

The substituted benzalmalononitriles listed in Table I were prepared essentially by the procedure of Corson and Stoughton.[2]

TABLE I

SUBSTITUTED BENZALMALONONITRILES

Substituents	Reaction solvent[a]	Cryst. solvent[a]	Yield, %	M. p., °C.	Formula	Analyses,[b] % Carbon Calcd.	Carbon Found		Hydrogen Calcd.	Hydrogen Found	
3-Chloro	*t*-Amyl	*n*-Butyl	85	116–117	$C_{10}H_5ClN_2$	63.68	63.86	63.79	2.67	2.75	2.73
4-Chloro	*i*-Propyl	Ethyl	80	162–163	$C_{10}H_5ClN_2$	63.68	63.79	63.69	2.67	2.84	2.76
2-Bromo	*n*-Butyl	*n*-Butyl	95	90–90.5	$C_{10}H_5BrN_2$	51.53	51.63	51.62	2.16	2.32	2.15
3-Bromo	*t*-Amyl	*n*-Butyl	81	109.5–110	$C_{10}H_5BrN_2$	51.53	51.64	51.62	2.16	2.24	2.23
3-Iodo	*t*-Amyl	*n*-Butyl	85	107–108	$C_{10}H_5IN_2$	42.88	43.01	42.93	1.80	1.90	1.91
4-Nitro	Ethyl	Ethyl	41	159–160	$C_{10}H_5N_3O_2$	60.30	60.42	60.30	2.53	2.66	2.68
3-Hydroxy	Ethyl	*t*-Amyl	59	151.5–153	$C_{10}H_6N_2O$	70.58	70.37	70.50	3.55	3.65	3.64
2-Methyl	*i*-Propyl	*n*-Butyl	51	104–106	$C_{11}H_8N_2$	78.55	78.55	78.57	4.79	4.79	4.93
3-Methyl	*i*-Propyl	*n*-Butyl	38	133–134	$C_{11}H_8N_2$	78.55	78.52	78.66	4.79	4.87	4.94
2,6-Dichloro	Ethyl	Hexane	56	89–90	$C_{10}H_4Cl_2N_2$	53.84	53.91	53.93	1.81	2.01	1.88
2-Chloro-5-nitro	*i*-Propyl	Ethyl	78	119–120	$C_{10}H_4ClN_3O_2$	51.41	51.51	51.60	1.73	1.87	1.86
2,4,6-Trichloro-3-hydroxy	*i*-Propyl	Benzene	70	135–136	$C_{10}H_3Cl_3N_2O$	43.90	44.12	44.05	1.10	1.26	1.26
4-(2-Chloroethylmercapto)	Ethyl	*t*-Amyl	..	87–88	$C_{12}H_9ClN_2S$	57.94	57.84	57.70	3.67	3.73	3.63
4-Methoxymethyl	Ethyl	Ethyl	61	72–73	$C_{12}H_{10}N_2O$	72.71	72.79	72.78	5.10	5.13	5.15
2-Thiophenalmalononitrile	Ethyl	Ethyl	50	95–96	$C_8H_4SN_2$	59.98	60.06	60.00	2.52	2.61	2.62
1-Naphthalmalononitrile	Ethyl	Ethyl	70	170–171.5	$C_{14}H_8N_2$	82.33	82.54	82.66	3.95	4.09	4.15

[a] Alcohols except as noted. [b] Microanalyses by Huffman Microanalytical Laboratories, Denver, Colo.

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(1) These compounds were prepared for the Office of Scientific Research and Development under Contract OEMsr-136 with Stanford University.

(2) Corson and Stoughton, THIS JOURNAL, **50**, 2825 (1928).

DEPARTMENT OF CHEMISTRY
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RECEIVED APRIL 8, 1949

Some Acylamino Acid Esters and Amides

The following previously undescribed esters and amides of butyrylglycine and acetylalanine have been prepared and characterized.

TABLE I

BUTYRYLGLYCINE DERIVATIVES

Compound			Ethyl ester	N-*n*-Butylamide	Anilide
Prepn. method			Esterify acid	Ester and amine	Na salt and aniline
M. or b. p., °C.			B. 136° (5 mm.)	M. 147.5–148.5	M. 158.5–159.5
Analyses, %	Carbon	Calcd.	55.5	60.0	65.43
		Found	55.23	60.09	65.5
	Hydrogen	Calcd.	8.73	10.06	7.32
		Found	8.58	9.75	7.22
	Nitrogen	Calcd.	8.08	14.0	12.72
		Found	7.95	14.16	12.96

Acetylalanine N-*n*-butylamide was prepared from the ethyl ester and *n*-butylamine, m. p. 114–115.2° from nitromethane.

Anal. Calcd. for $C_9H_{18}O_2N_2$: C, 58.04; H, 9.74; N, 15.05. Found: C, 58.10; H, 9.26; N, 14.88.

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RECEIVED DECEMBER 6, 1948

N,N-Dicyclohexylformamide

In the course of the preparation of tertiary amines from N,N-dialkyl amides, there was occasion to prepare N,N-dicyclohexylformamide, a white, wax-like compound. To the best of our knowledge, the preparation of this substance has not been reported previously.

Fifty ml. of water and 108.4 g. of 85% formic acid were added to a 500-ml., 3-neck, round-bottom flask equipped with a dropping funnel in one side neck, a water-cooled reflux condenser in the other side neck and a mercury-sealed mechanical agitator in the center neck. The solution was warmed to 50°, when the dropwise addition of 90.5 g. of dicyclohexylamine was begun. After the amine was completely added, the solution was allowed to agitate for fifteen minutes, when it was transferred to a Claisen flask. The water and some of the excess formic acid were removed by distillation at atmospheric pressure, followed by vacuum distillation. The fraction distilling at 195–201° at 29 mm. was collected in 90% yield, resulting in a white, wax-like solid upon cooling. Recrystallization from isopropyl alcohol gave 89.9 g. (86%) of N,N-dicyclohexylformamide, m. p. 62.5–63.5°. *Anal.* Calcd. for $C_{13}H_{23}NO$: N, 6.69. Found: N, 6.58.

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RECEIVED APRIL 15, 1949

COMMUNICATIONS TO THE EDITOR

THE SPONTANEOUS IGNITION OF ALUMINUM BOROHYDRIDE VAPOR IN OXYGEN[1]

Sir:

We would like to report some preliminary observations on the ignition of aluminum borohydride vapor $(Al(BH_4)_3)$ in oxygen. This volatile compound (b. p. 44.5°) was first prepared by Schlesinger and associates, and was found by them to ignite spontaneously when exposed to laboratory air.[2] We have somewhat extended their observations on the inflammability of the vapor.

Experiments were carried out in clean spherical Pyrex bulbs (6.6 cm. diameter) attached to a system of storage bulbs, mercury manometer and pump. The vapor was first introduced into the bulb to the desired pressure and a predetermined amount of oxygen was then run in quickly. The mixture was usually observed for a period of a kilosecond (1000 seconds—about seventeen minutes), but it was generally found that there was either no change at all, or else immediate explosion.

With *dry* oxygen, no explosions occurred on filling at 20°, over a range of 1 to 300 mm. (14 mole % $Al(BH_4)_3$), though on subsequent evacuation ignition almost always followed. This might indicate an upper pressure limit but we have no evidence of this in the pressure range studied.

Explosion was observed at higher temperatures. Thus at 110° the lower pressure limit was 25–30 mm. for mixtures of 5–50 mole % $Al(BH_4)_3$.

With *moist* oxygen, explosion occurred at 20°. When the oxygen was saturated at this temperature (2.3 mole % H_2O) explosions were observed from 5–90 mole % $Al(BH_4)_3$, the minimum total pressures running from 25–75 mm. A few experiments with half-saturated oxygen indicated that minimum pressures were roughly doubled, as if a minimum partial pressure of water vapor (about 0.5 mm., but depending somewhat on composition) was required for explosion.

Since Schlesinger has reported that aluminum borohydride is subject to rapid hydrolysis, it would appear that this reaction is a prerequisite to explosion at room temperature. In the absence of water vapor, decomposition at a higher temperature may serve the same purpose.

Further work on the ignition and also the decomposition of aluminum borohydride is in progress.

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RECEIVED MARCH 24, 1949

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[1] The work described in this paper was done in connection with Contract NOrd 7920 with the United States Naval Bureau of Ordnance, as coördinated by the Applied Physics Laboratory, The Johns Hopkins University, and with Contract N6-ori-105, T. O. III Project Squid, with the Office of Naval Research, as coördinated by Princeton University. Acknowledgment is due Dean Hugh S. Taylor, who has general supervision of this project. The samples of aluminum borohydride were kindly supplied by the Naval Research Laboratory.

[2] H. I. Schlesinger, R. T. Sanderson and A. B. Burg, THIS JOURNAL, **62**, 3421 (1940).

THE DESCRIPTION OF BEHAVIOR BY PHYSICAL PROPERTIES

Sir:

Dr. Telang's recent note and letter[1] in which he recalls Ferguson and Kennedy's[2] revised parachor $P_r = MC^{1/p}$ where $1/p$ is an exponent whose magnitude differs for different substances, raises the whole problem of the description of behavior when physical properties lose their invariance. P_r is no longer a "property" of the atom, molecule or radical but corresponds to those entities which, in rheology, have been called "quasi-properties."[3,4] Comparisons between substances can be made only in terms of both the intensity factor C and the exponent $1/p$; neither has meaning apart from the other.

The analogy between this treatment and Nutting's equation or Bach's power law[5] relating stress and strain, is exceedingly close.

Will a similar type of quasi-property be needed for the accurate formulation of rheochors[6] and thermochors?[7]

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RECEIVED JUNE 20, 1949

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[1] M. S. Telang, THIS JOURNAL, **71**, 1883, 1898 (1949).

[2] A. Ferguson and S. J. Kennedy, *Trans. Faraday Soc.*, **32**, 1474 (1936).

[3] G. W. Scott Blair, B. C. Veinoglou and J. E. Caffyn, *Proc. Roy. Soc.*, **189A**, 69 (1947).

[4] G. W. Scott Blair and J. E. Caffyn, *Phil. Mag.*, **40**, 80 (1949).

[5] C. Z. Bach, *Ver. dtsch. Ingen.*, **32**, 192 (1888).

[6] J. N. Friend, *Nature*, **150**, 432 (1942), etc.

[7] H. G. de Carvalho, *ibid.*, **160**, 370 (1947).