Title
AN ELECTROMOTIVE FORCE OF FUSION

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An electromotive force has been measured between electrodes immersed in several different molten inorganic compounds near their melting temperatures when one of the electrodes is depositing crystals, or when crystals are melting. The maximum electromotive force (EMF) values measured at the onset of crystal formation correspond closely to reported heat of fusion values, H_f, as shown in Table 1. The averages of measured values are listed where more than two values were obtained. In the cases of K_2CO_3, Na_2CO_3 and Na_2SO_4, values of 4001, 3776 and 3113 cal/mole respectively were also measured and may indicate preferential crystallization of dimers or the transfer of two equivalents of electrons per mole of compound for these experiments. In several cases the measured EMFs clustered at intervals of one to two hundred cal/mole. Examples are shown in Table 1 for Na_2SO_4. This may indicate crystallization modes that result in differences in initial and final states.

The experiment is usually started with both electrodes immersed in the molten liquid. This allows a check on extraneous junction or oxide layer potentials which might occur due to a difference in oxidation state or chemistry of the electrodes. Also, any initial strain or polarization EMFs are easily measured. Such EMFs have been observed to build up to the order of 1 or 2 volts (23.06 kcal per volt) when the whole melt crystallizes.

The experiments were performed over a Fisher burner with air and gas inlets. The burner was turned down or off during EMF measurements.

The measured values were obtained with several sets of platinum wire electrodes which varied in size. Iridium electrodes were also used with comparable results. Most experiments were performed by establishing slight temperature gradients in order to favor crystallization or dissolution at one electrode, or, one electrode was repeatedly dipped into slowly cooling liquid while recording temperature and the EMF. In several cases constant EMF of fusion values were obtained for prolonged periods by keeping one electrode in the melt while the other barely touched the surface.

The observed EMF is thought to be due to a difference in chemical potential between the forming crystal or surface and the molten liquid, which is also the difference in Fermi brim energy for the electrons[1]. The data are in agreement with the definition of Fermi brim energy as a function of density or number of conduction electrons per unit volume[1]. In the present experiments, the crystal was denser than the molten liquid, and the crystal forming electrode acted as a cathode, giving electrons to the molten liquid.

It is suggested that the electromotive forces, currents, and inferred chemical potential differences measured in these experiments may help in understanding or formulating experiments in relation to some of the phenomena observed or postulated in studies of volcanism, crystallizing magmas, magnetic fields, strain energies and earthquakes.

The integral ratios observed for the EMF values of salts with common anions may be related to crystal symmetries.

REFERENCES

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TABLE 1. EMF and Heat of Fusion (H_f) values

Compound	Number of Measurements	EMF (cal/mole)* Measured	H_f (cal/ g mole) Reference 2
LiF	6	2482 ± 33	2360
Li_2SO_4	15	3045 ± 31	3040
K_2CO_3	2	7764 7785	7800
	1	4001	
Na_2CO_3	2	7663 6791	7000
	2	3996 3556	
NaF	3	7394 ± 56	7000
Na_2SO_4	23	5957 ± 37	5830
	2 9 10 2	6232 6095 5835 5672	
	1	3113	

*EMF values are reported in cal/mole assuming 1 eV=23,060 cal/mole. Standard deviations are given where applicable.

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