Molten Carbonate Electrolyte-Based Thermocells

for High Temperature Waste Heat Recovery

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A thermoelectric energy converter is able to convert excess heat from various sources at various temperatures to electric energy. Waste heat is an abundant source of energy in the process industry. The efficiency of this conversion is normally low, but research has so far focused on the use of semiconductor materials. Seebeck coefficients of (cheap) semiconducting materials amount to 0.3 mV/K.

Theoretical descriptions of the thermoelectric cell [1], predicts that molten salts (ionic liquids) and gas electrodes can increase this value several times. We report measurements of Seebeck coefficients for molten alkali carbonate mixtures with carbon dioxide and oxygen gas on gold or platinum electrodes, confirming a first study from 1977 of this cell [2]. Results are presented for pure (Li_2CO_3) and mixed carbonates (*e.g.* Li_2CO_3, K_2CO_3(l)) at stationary state, in the absence and presence of MgO(s) and other oxides dispersed, and in the temperature range 550 - 750 ^oC. These are all cheap and commonplace materials.

The composition of oxygen, carbon dioxide and helium were systematically varied, and shown to confirm the theoretically expected stoichiometry of the electrode reaction. The Seebeck coefficient varied between 1.2 and 1.4 mV/K depending on the electrolyte composition; the highest values were typical for mixtures of alkaline carbonates. A large dependency was found on the particle type and size of the solid oxide [3,4].

The data enable us to prescribe operating conditions for thermoelectric converters with higher Seebeck coefficients. The work supports the idea that the technology could benefit from systematic studies of complex-formers and gas reactions in the electrolyte.

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