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Potential of Thermoelectric Generators based on Ionic Liquids

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In advanced thermoelectric materials the key aspect lies on the reduction of the thermal conductivity while maximizing electric carrier transport. Skutterudites, clathrates, half-Heusler alloys and complex chalcogenides, nanomaterials, thin-film properties are only examples of tracks which are taken to optimize material properties for thermoelectric applications.

New in the row of the advanced materials are Ionic Liquids (IL) which were investigated regarding their thermoelectric properties only by a few research groups in the last years [1-3]. ILs are organic salts that exist as liquids below a threshold temperature, various at room temperature, and constitute a new generation of solvents composed of 100% of cations and anions.

Due to low thermal conductivities (e.g. [BMIM][BF_4] λ=0.184W/mK [5]) the temperature gradient between hot and cold electrode is maintained and high Seebeck coefficients (e.g. [BMIM][BF_4] S=850µV/K [4]) could be shown. In contrast, the electrical conductivity ([EAN][NO_3] σ=2.82S/m [4]) is low, however investigations showed that the measured AC electrical conductivity appears being de-coupled from the power output of the cell [4].

The possibility to fine-tune practically all the IL physiochemical properties by modifying its chemical structures makes IL truly designer solvents and might allow the optimization of the thermoelectric properties. Out of 20 tested ILs a large range of Seebeck coefficients and Power outputs could be observed.

The potential of ILs does not only lie in the promising thermoelectric properties, liquids could also open new fabrication methods regarding flexible TEG modules using the Solid-on-Liquids Technology [6]. Moreover the reliability of TE modules might be improved by ensuring a stable interface. The performance of TE modules degrades with thermal cycling as the constituent materials and the interfaces are exposed to large temperature gradients. This increases the internal resistance caused by poor contact between a thermoelectric material and the electrode [7].

This review discusses the challenges and the potential of ionic liquids for thermoelectric applications.

Keywords: Ionic Liquids, Thermoelectricity, Flexible TE modules,

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