Design of new ionic liquids with increased O_2 solubility for Li-O_2 battery

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In the past decade, Li-O_2 battery received a lot of attention since it gives the promise of large energy density which would potentially increase the range of Electric Vehicles (EV) above 400kms, reducing the customer range anxiety and therefore supporting a better penetration of EV in the market. Despite numerous studies, Li-O_2 battery remain an immature technology facing several challenges [1]. An important one is the electrolyte selection which is until now not resolved since the requirements for Li-O_2 battery electrolyte are even stronger than for Li-ion battery. Especially high O_2 solubility and O_2 diffusivity and low vapor pressure are important extra parameters to consider.

Ionic liquids (ILs), solvent consisting entirely of ions, present unique properties such as low volatility, high (electro) chemical stability, intrinsic electrical conductivity, thermal stability and are highly tuneable. Previous studies reveal that N;N-diethyl-N-(2-methoxyethyl)-N-methylammonium bis(trifluoromethylsulfonyl)imide (DEME-TFSI) was stable against O_2 radicals which is not the case of the common organic solvents such as carbonates or glymes used in Li-ion battery [2-3]. On the downside, one of the disadvantage of DEME-TFSI lies in its low O_2 solubility combined with a high viscosity, penalizing in the same time the O_2 diffusivity.

In order to increase the O_2 solubility, our approach was therefore to design new ionic liquids functionalized with fluorine, making them an intrinsic part of the electrolyte [4]. We will report the synthesis and characterization of those new ionic liquids, before to discuss their O_2 properties determined by electrochemical measurements combining the Cottrell equation on a macro-electrode and the steady-state current on an ultra-microelectrode.

References:

[1] Y-C Lu, B. M. Gallant, D. G. Kwabi, J. R. Harding, R. R. Mitchell, M. S. Whittingham, Y. Shao-Horn, 752 Energy Environ. Sci. (2013), 6, 750–768.
[2] H. Nakamoto, Y. Suzuki, T. Shiotsuki, F. Mizuno, S. Higashi,K. Takechi, T. Asaoka, H. Nishikoori and H. Iba, J. Power Sources (2013) **243**, 19–23.
[3] S. A. Freunberger, Y. Chen, F. Bardé, K. Takeuchi, F. Mizuno, P. G. Bruce Springer (2014)
[4] G. Vanhoutte et al. Submitted.