

Influence of electrolyte additives on the gassing behaviour in silicon based lithium-ion batteries

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Abstract

The complex combination of components of the battery leads to chemical processes and side reactions of the battery and electrolyte components. The stability of the electrolyte is an important point for a long service life and safety of the battery. The generation of gases during charging and discharging cycles indicates the degradation of the electrolyte, which can lead to a decrease in usable capacity. With precise knowledge of the gases produced, valuable indication of the degradation reactions taking place in the cell can be determined.

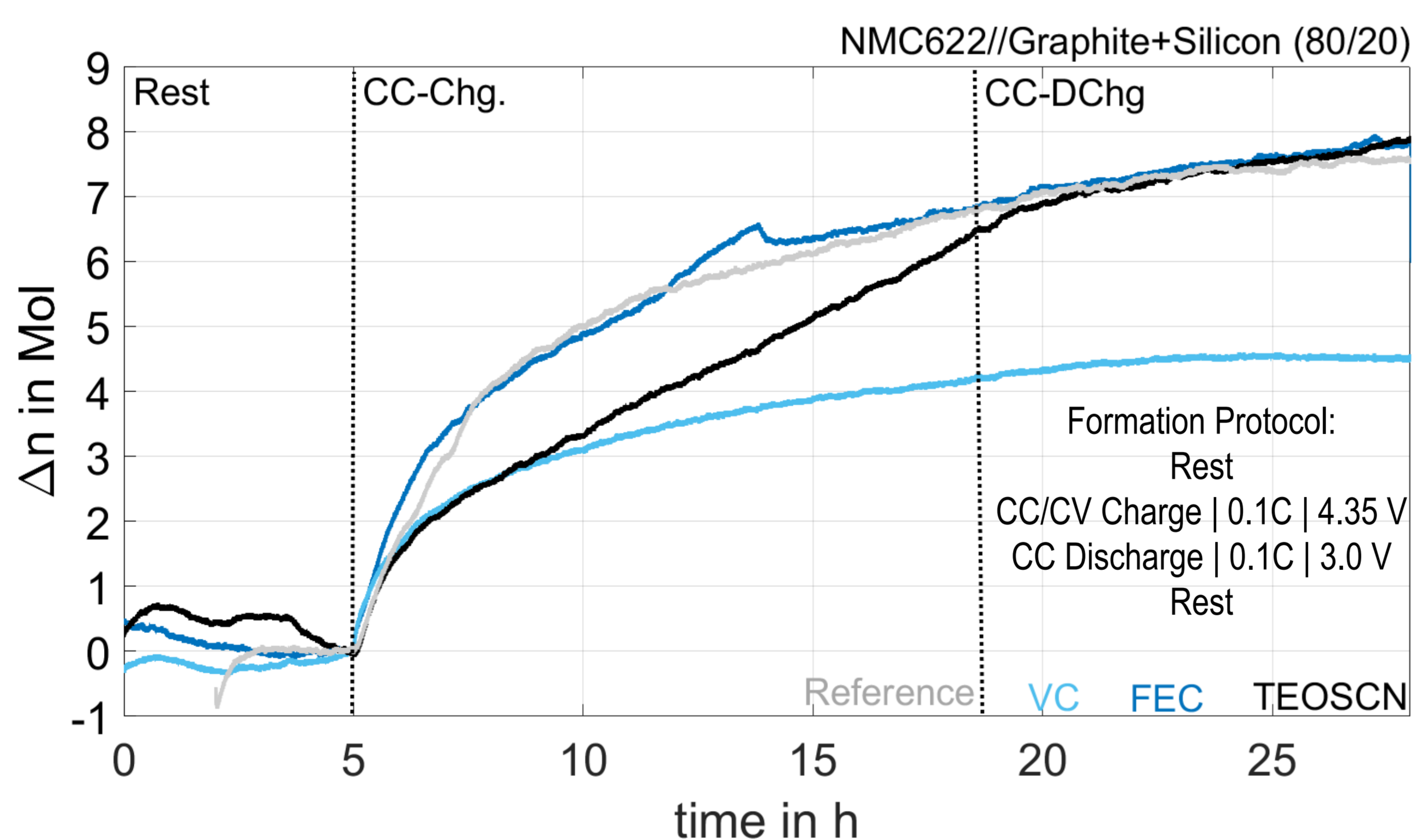
Conclusion

We measured the production of gases and their composition during formation of lithium-ion batteries with different additives. The results of the gas analysis indicate that the use of electrolyte additives has a strong influence on the composition and the overall gas production of gases in the gas phase of the battery. The corresponding changes in the gas share allow conclusions to be drawn about changed reaction processes, including the formation of the SEI.

Setup

- Cell-Gas testing system from EL-CELL[®] to obtain electrical data and pressure as well as temperature data
- 18 Ø mm coin-cell size of the electrode
- Gasport for manual sampling
- The gas sample were measured using a GC-MS system with two columns to separate volatile gases
- 5% FEC^{*}, VC^{**} and TEOSCN^{****} were used as additives in 1M LiPF₆ EC/EMC (3:7)

*fluoro ethylene carbonate, **vinylene carbonate, ****3-(Triethoxysilyl)propionitrile

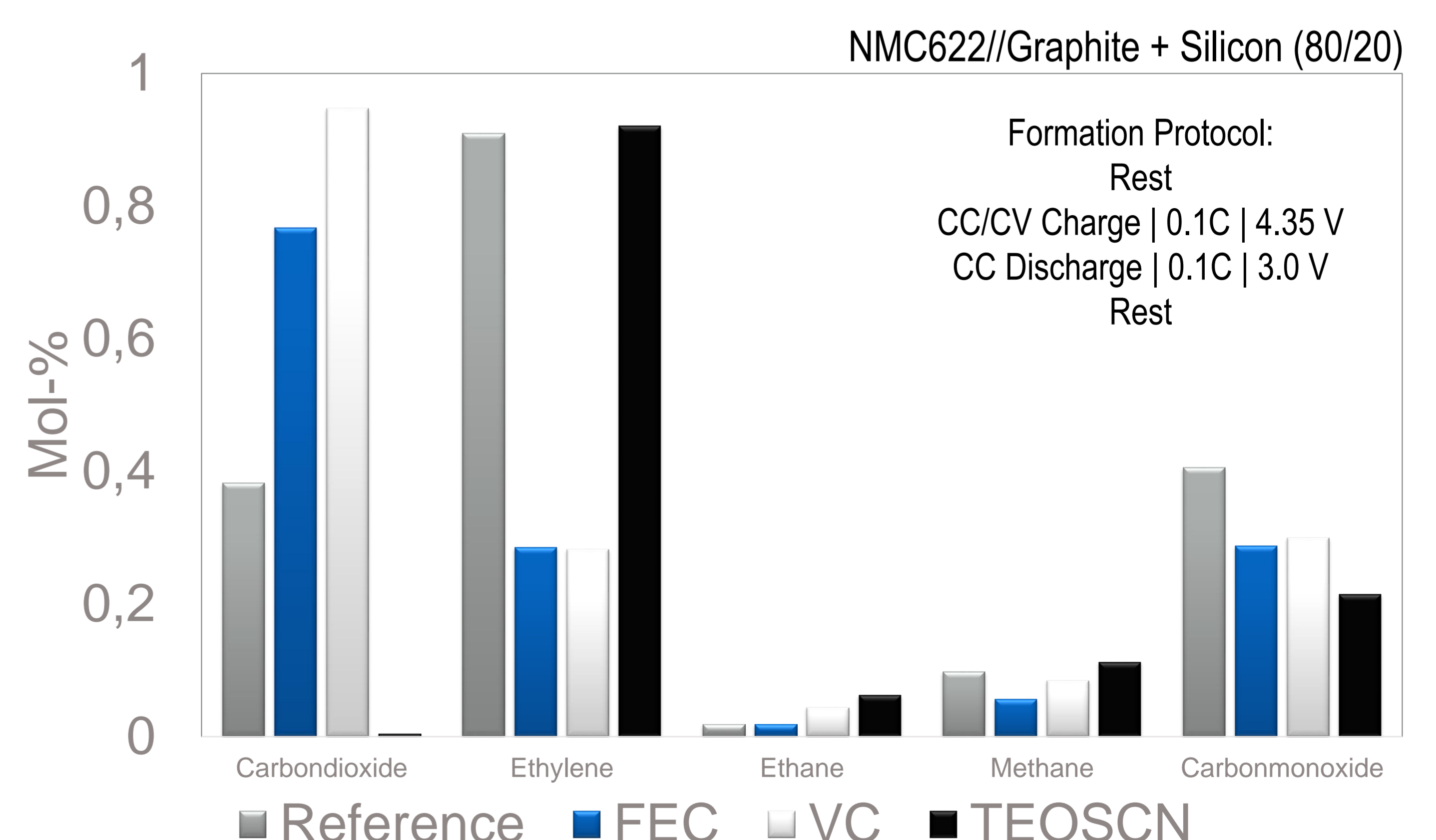


Gas production during formation

- VC as additive leads to the lowest overall gas production
- FEC lead to no significant change in gas production
- TEOSCN initially leads to a reduction, but ends up at the same level as the reference cell
- Gassing starts when a current is applied
- The gas production was determined by measuring the pressure change and calculation via ideal gas equation to compensate changes in temperature

Additive related gas shares after formation

- VC and FEC leads to a higher share of CO₂, and TEOSCN lead to the almost complete absence of it
- The generated CO₂ may be beneficial for SEI and serve itself as an additive [1]
- The share of Ethylene is significantly reduced compared to the reference cell or the use of TEOSCN, using VC or FEC
- Low share of Ethane and Methane independent of the additive
- The share of CO is reduced using FEC and VC and even more using TEOSCN



[1] L. J. Krause *et al.*, J. Electrochem. (2017), doi: 10.1149/2.1121712jes.

