Known and unknown of direct air capture amine materials

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One of the proposed technologies to reduce greenhouse gas concentration in the atmosphere relies on direct air capture (DAC) using sorbent materials. These can be discharged for storage or feedstock commercialization in a cycling approach between capture and release. For CO_2, amine-functionalized polymers have been proposed.[1] The latter are able to reversibly bind CO_2 from air by forming carbamates and then release it upon moderate heating at low pressure and followed by a new DAC cycle.
The increasingly rapid development of amine-based adsorbents for the removal of CO_2 is already at commercial-scale implementation. In the last decade, significant progresses have been made in understanding the CO_2-amine interaction. Said et al.[2] proposed a unified six membered mechanism to propose all possible interactions of CO2 with amines and water. Unfortunately, the CO_2 capturing capacity rapidly degrades with cycle. This has been attributed to parasitic chemical pathways such as oxidative degradation and other deactivation processes. The level of information on the chemical pathways is clearly determined by the depth of analytical coverage.

Spectroscopic techniques along with Mass Spectrometry techniques allow the investigation of such mechanisms as well as the formation of not yet identified compounds.
The adsorbent was characterized by FTIR, ATR, XPS, SEM, ICP-MS, ToF-SIMS and GC-MS before and after the exposure to air under different conditions.
As a result of the data achieved, a special cell for operando chemistry is being realized for the real time detection of organic groups as well as elemental traces. Data integration is promising to generate important insight, but presents a number of discussed challenges.

[1] H. Bryan et al., *Civil Eng. Archit.* **2018**, 6(3): 155-163.
[2] R. Ben Said et al., *ACS Omega* **2020**, 4, 26125-26133.