Carbon Capture through Ga-based Liquid Metal Alloys

Graduate

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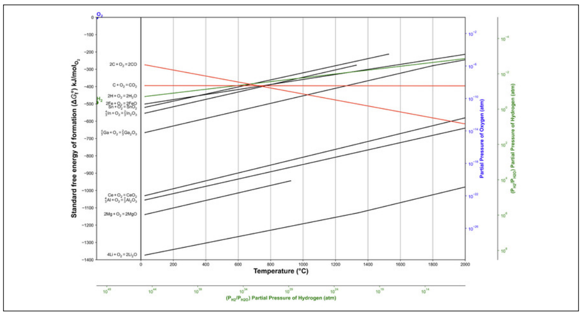
Introduction: To reduce greenhouse gas emissions, fossil fuels need to be replaced by renewable energy sources. Carbon capture storage (CCS) is a negative emissions technology that can offset these emissions. CCS involves the capture of CO_2 from various sources and its subsequent storage. Four main methods of carbon capture are possible: post-combustion, pre-combustion, oxyfuel, and chemical looping. The impact of CCS is expected to increase in the future to achieve net-negative CO_2 emissions by the second half of the century.

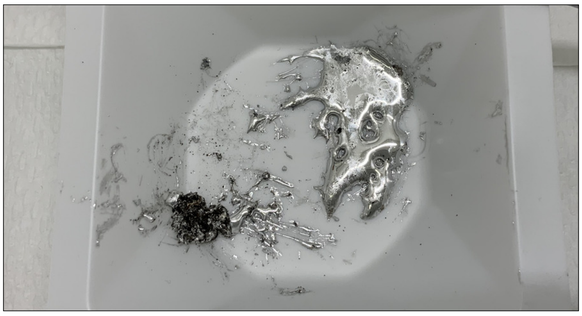
Approach / Technology: Gallium-based liquid metals have demonstrated the potential to reduce CO_2 into solid carbon. This study investigates the potential of different gallium-based liquid metal alloys for carbon capture. The reaction is conducted in a bubble reactor containing a metal alloy that is liquid at room temperature. Argon and CO_2 bubble through the reactor before the gas is analysed using a mass spectrometer (MS). The research focuses on the influence of doping materials on the CO_2 conversion efficiency and the characterization of reaction products. Additionally, the test setup was adapted to accommodate the new reactor design.
Iron and aluminum were selected for alloying and testing. The samples were prepared by alloying 8 ml of eGaInSn with 3 wt% of each material. The alloying process and entire testing procedure were carried out in an inert environment to prevent the oxidation of the samples.

Result: Gas analysis did not show a clear trend of increased CO_2 conversion at higher temperatures for all samples tested. After the gas analysis, long-term testing was performed by running CO_2 through the reactor to form reaction products. Scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM/EDX) analysis confirmed the successful alloying of the samples and indicated the presence of carbon in the reaction products of all samples. This proves the CO_2 decomposition inside the reactor.

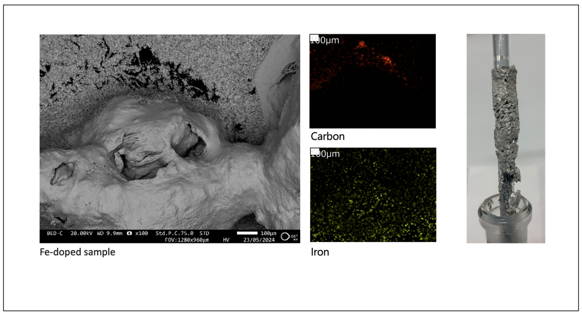
Ellingham diagram of selected metals and oxides.
Own presentment



Initial testing with eGaInSn.
Own presentment



SEM/EDX analysis (left) and reaction products (right) of the iron-doped sample.
Own presentment



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