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Development of a Method for CO Production from Air Using Ionic Liquids and Low-Temperature Plasma

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Climate change is one of the most critical challenges of our time, and CO_2 emissions are considered its primary cause. To mitigate this issue, the integration of CO_2 capture, storage, and conversion technologies has attracted significant attention. In particular, CO_2 capture and conversion can be extended through selective irradiation of chemical species and also serve as an important process for promoting plant growth via plasma treatment.

The decomposition of CO_2 using plasma has been studied in previous studies [1], but these studies typically target CO_2 concentrations close to 100%. However, in practical applications, CO_2 concentrations are often much lower, requiring additional purification steps before conversion, which presents a major challenge. To address this issue, a novel approach is proposed in which CO_2 is captured prior to plasma irradiation and then converted to CO on-site, enabling simultaneous capture and conversion. In this study, the ionic liquid 1-butyl-3-methylimidazolium chloride ([Bmim]Cl) was used. This ionic liquid is known to be stable under plasma conditions and capable of efficiently capturing CO_2 [2–4].

Using [Bmim]Cl, CO_2 was captured from ambient air, stored for 24 hours, and then successfully converted to CO via non-thermal plasma [5,6]. This represents the first attempt to integrate CO_2 capture and conversion into a single process using an ionic liquid. A graph is presented with CO yield on the vertical axis and ionic liquid concentration on the horizontal axis. Compared to water, the CO yield using the ionic liquid increased by up to approximately 1.43 times, showing a trend of increasing yield with higher concentrations. Additionally, an experiment was conducted using air containing low concentrations of CO_2 instead of pure CO_2, in which CO_2 was captured and converted to CO via plasma. In this case, the CO yield using the ionic liquid was approximately 1.72 times higher than that of water. These results suggest that CO_2 capture using ionic liquids and its conversion to CO via plasma irradiation in the same system is feasible regardless of CO_2 concentration. Furthermore, the presence or absence of bubbling also affected the CO yield, with higher yields observed when bubbling was applied. This serves as supporting evidence that the generated CO originates from CO_2 rather than from the ionic liquid itself.

These experimental results indicate that ionic liquids, particularly [Bmim]Cl, offer a promising and practical method for CO_2 capture, storage, and conversion under atmospheric pressure and room temperature. This approach holds significant potential for sustainable CO_2 management and paves the way for practical applications in environmental and industrial processes.

References

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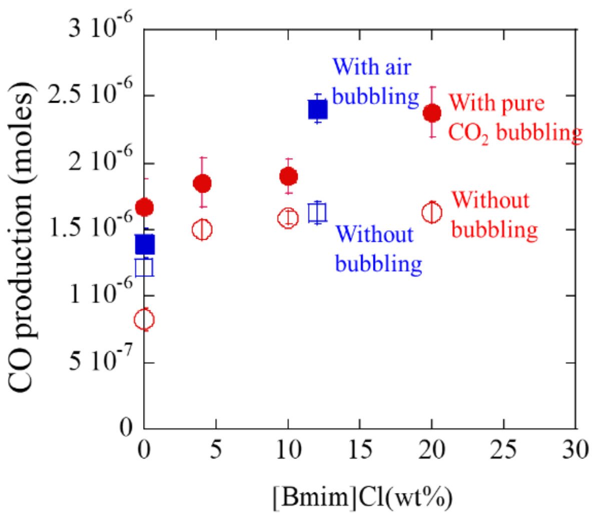

Fig.1. Effect of ionic liquid concentration on CO production under plasma irradiation.
(Blue: Low CO_2 Concentration, Red: High CO_2 Concentration)