Contribution ID: **4** Type: **Keynote Presentation (paper for Ironmaking & Steelmaking special issue)**

Production and Evaluation of a Carbon-Recycled Carburizing Agent to Promote the Melting of Direct Reduced Iron

Tuesday 12 May 2026 17:10 (20 minutes)

Global crude steel production has shown a steady increase in recent years, with approximately 70% produced via the blast furnace–basic oxygen furnace (BF–BOF) route and the remaining 30% by the electric arc furnace (EAF) process. The BF–BOF route consumes a large amount of fossil-based carbon materials, resulting in significant CO_2 emissions. Therefore, the transition from the BF–BOF process to the EAF process is considered a key pathway toward achieving carbon-neutral steelmaking. The EAF process produces molten iron by melting metallic scrap and direct reduced iron (DRI) using electric arc heat. Although it is a greener process with lower carbon consumption, a certain amount of carbon must still be added to lower the melting point of iron and to promote slag formation, which protects the furnace lining. Thus, even in EAF steelmaking, the use of carbon-neutral carbonaceous materials is essential.

Previous studies have explored the use of biomass as a carburizing agent. Biomass-derived carbon exhibited a dissolution rate of metallic iron comparable to that of anthracite, indicating its potential as a renewable carbon source. However, biomass supply is limited by availability, logistics, and cost, making it difficult to support large-scale steel production. To overcome this limitation, new sustainable carbon supply routes must be developed.

In this study, we focus on carbon capture and utilization (CCU) technology to recycle carbon emitted from steelmaking processes. We propose a novel approach in which the off-gas from the process is reformed using a metallic iron catalyst to recover solid carbon for reuse. The recovered carbon mainly consists of fibrous carbon several hundred nanometers in diameter and fine iron carbide particles. When this deposited carbon is briquetted with metallic iron particles and subsequently heated, it demonstrates excellent melting characteristics due to enhanced interfacial reactivity.

In situ observation experiments revealed that briquettes containing the deposited carbon melted at lower temperatures than those using conventional graphite as a carburizing agent. This result indicates that the deposited carbon promotes earlier melting and efficient heat transfer. The proposed CCU-based carbon recycling route offers a promising solution for reducing both carbon consumption and CO_2 emissions in EAF steelmaking. Overall, this study provides a new perspective on utilizing recovered carbon as a functional and sustainable carburizing material, contributing to the realization of truly carbon-neutral steel production.

Speaker Country

Japan

Speaker Company/University

Tohoku University

Primary authors: HIGASHI, Ryota (Graduate School of Environmental Studies, Tohoku University); MURAKAMI, TAICHI (Tohoku University)

Presenter: HIGASHI, Ryota (Graduate School of Environmental Studies, Tohoku University)

Session Classification: Recent progress and new developments in CCS/CCU

Track Classification: EMECR: EMECR 10. Recent progress and new developments in CCS/CCU