Influence of surface-active elements on nucleation of non-metallic inclusions

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The composition and temperature of steel melts play vital roles in determining the size, type, and chemistry of non-metallic inclusions. During the production of steel melts, significant changes in composition and temperature occur, leading to evolving melt purity. Steel purity, characterized by low concentrations of non-metallic inclusions, plays a pivotal role in determining the mechanical properties and overall quality of steel and iron-based alloys, including corrosion resistance, fatigue resistance, formability, and weldability. Thermodynamic calculations for the formation of non-metallic inclusions are complex and require assumptions and simplifications, primarily considering the activity of elements in relation to composition and temperature. These calculations often overlook surface energy, which is crucial for calculating the critical radius of non-metallic inclusions.

The present research investigates the influence of surface-active elements, specifically sulfur, on non-metallic inclusion nucleation in the Fe-C alloy system. The study aims to illuminate how these elements alter the surface tension of the melt and subsequently affect the formation of non-metallic inclusions. In the realm of basic research, experimental equipment for determining surface tension values using the sessile drop method has been developed. We will explore potential applications in the steelmaking and foundry industries.

The outcomes of the research are anticipated to have a significant impact on steelmaking practices. Understanding the interplay between surface-active elements, surface tension, and non-metallic inclusion formation is crucial for improving material quality, enhancing industrial processes, and reducing technological disruptions, such as nozzle clogging during continuous casting.