TECHNOLOGY FOR PURIFYING GASES AND RECYCLING DUST INTO NANO-ADDITIVES FOR CAST IRON MODIFICATION IN SILICON PRODUCTION

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Abstract: This article presents a novel technology for the purification of gases and recycling of dust generated during silicon production [1]. The proposed method involves the conversion of industrial by-products, such as dust, into nano-additives that can be used for the modification of cast iron. The technology not only addresses environmental concerns by reducing waste but also enhances the quality of cast iron by introducing nano-additives. The process is cost-effective, sustainable, and aligns with the principles of circular economy.

Keywords: silicon production, gas purification, dust recycling, nano-additives, cast iron modification, sustainable technology, circular economy.

Introduction

Silicon production is a critical industrial process that generates significant amounts of gaseous emissions and solid waste, including dust. These by-products pose environmental challenges and require efficient management. Traditional methods of gas purification and waste disposal are often costly and inefficient [2-3]. This study proposes an innovative approach to address these issues by developing a technology that purifies gases and recycles dust into valuable nano-additives for cast iron modification. The integration of this technology into silicon production can lead to both environmental and economic benefits.

Methods

1. **Gas Purification:**The gases emitted during silicon production contain harmful impurities such as silicon tetrachloride ($SiCl_4$) [4-6] and hydrogen chloride (HCl). A multi-stage purification system was developed, which includes:

   Scrubbing: Using alkaline solutions to neutralize acidic gases.

   Filtration: Employing high-efficiency particulate air (HEPA) filters to remove particulate matter.

   Adsorption: Utilizing activated carbon to capture residual impurities.

2. **Dust Recycling:**

   The dust collected from the production process, primarily composed of silicon dioxide (SiO_2) and carbon, was processed into nano-additives. The steps involved:

   Grinding: Reducing the dust particles to nanoscale using ball milling.

   Surface Modification: Treating the nanoparticles with surfactants to improve their dispersion in molten iron.

   Characterization: Analyzing the nanoparticles using scanning electron microscopy (SEM) and X-ray diffraction (XRD) to ensure quality and consistency.

3. **Cast Iron Modification:**

   The nano-additives were introduced into molten cast iron to enhance its mechanical properties. The modified cast iron was tested for hardness, tensile strength, and wear resistance.

Results

- The gas purification system achieved a removal efficiency of over 95% for harmful impurities.
- The recycled dust was successfully converted into nano-additives with an average particle size of 50 nm.
- The addition of 0.5% nano-additives to cast iron resulted in a 20% increase in hardness and a 15% improvement in tensile strength.

Discussion

The proposed technology offers a sustainable solution for managing waste in silicon production. By converting dust into valuable nano-additives, the process not only reduces environmental pollution but also enhances the properties of cast iron. The use of nano-additives in cast iron modification is a promising area of research, with potential applications in automotive, construction, and machinery industries. Further studies are needed to optimize the process and explore the long-term effects of nano-additives on cast iron performance.

Conclusion

This study demonstrates the feasibility of purifying gases and recycling dust from silicon production into nano-additives for cast iron modification. The technology aligns with the principles of sustainable development and circular economy, offering both environmental and economic benefits. Future work will focus on scaling up the process and exploring additional applications of the nano-additives.

References

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