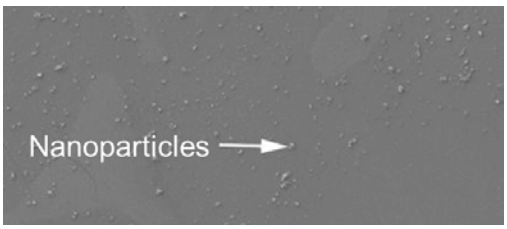
AMC
AMERICAN METALCASTING CONSORTIUM

# Developing Options to Produce Nanostructured Cast Alloys

**Program Overview and Objectives:** This AMC research project, managed by the American Foundry Society (AFS) and Eck Industries, is developing methods for the large-scale production of nanoreinforced aluminum alloys. These alloys can be significantly stronger than standard aluminum alloys, but have equivalent density, making them ideal candidates for structural military components. Lessons learned from previous developmental work and other projects are being leveraged to scale up and implement the technology.

## SUCCESS STORY

**Problem:** Reinforced aluminum alloys are produced by adding nanosized particulates into molten aluminum. Past research has shown that the addition of small particles of oxides and carbides, between 30-100 nm in an aluminum alloy, at particle loadings of only two weight percent, has been demonstrated at small scale to increase yield strength by up to 50%. However, it is very difficult to get small size particles into the melt at a production-level scale. The surface tension of the melt and poor wettability of most ceramic or carbide particles lead to very slow processing and high numbers of particles that are not incorporated.




**Solution:** The project goal is to produce a casting with a 20-30% improvement in mechanical properties. Multiple solutions are being explored to make the incorporation of nanoparticles into aluminum cost effective. Recent work has focused on the use of a reactive flux mixed with carbon to produce nanosized titanium carbide. This is accomplished by mixing a titanium-containing flux with an activated carbon and adding the material to the melt surface. The flux serves to protect the melt during processing.

In this research, significant amounts of particles were formed, and the size of the particles was not tied closely to the carbon precursor, suggesting that lower-cost carbon can be used. Since other alloys could interfere with the reaction, this procedure would be used to produce master alloys which could then be added to standard casting alloys to improve their strength.

**Benefits:** This in-situ technique was approximately ten times faster than ex-situ processing, significantly reducing the costs of nanocomposite castings. Lab scale demonstrations are encouraging. This work is still in progress and significant characterization and alloy development will be required for scale up to full size castings.

*Heavy duty steering knuckles are potential applications for nano-reinforced aluminum alloys.*

*"This project is a classic example of trying to bridge lab-scale research to consistent and affordable commercial products. The difficulty is substantial, but the payoff is huge. The key is using industry practices to implement the laboratory knowledge to understand what can be accomplished in a production environment."*

David Weiss, Vice President of Research and Development of Eck Industries

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