

The project aims to develop a new approach for producing specialized magnetic materials known as NdFeB alloys. These are composed of neodymium, iron, and boron, and are used to make powerful permanent magnets. Such magnets are essential components in modern technologies, including electric motors, hard drives, wind turbines, and electric vehicles.

Currently, two main methods are used to manufacture these materials. The first is gas atomization, where molten metal is sprayed using a high-pressure gas stream. While this method is efficient at industrial scale, it is uneconomical when only small quantities of powder are needed for research. The second is sintering, in which powders are pressed into shape and then heated to high temperatures. However, this method only allows for simple geometries and limits the ability to further process the material.

This project proposes an innovative approach by combining three advanced technologies. The first step will involve ultrasonic atomization, a modern method that enables fast and precise production of small quantities of high-quality powder. This makes it possible to test a wide range of alloy compositions without consuming large amounts of raw materials.

Next, the powder will be processed using metal 3D printing, specifically Laser Powder Bed Fusion (LPBF), in which a laser selectively melts thin layers of powder to create complex three-dimensional objects. Finally, a hydrogen-assisted heat treatment known as HDDR (Hydrogenation–Disproportionation–Desorption–Recombination) will be applied to enhance the magnetic properties by altering the material's internal structure.

The main goal of the project is to develop and thoroughly investigate a complete methodology that integrates these three technologies. Particular focus will be placed on studying the relationships between printing parameters, internal structure, and magnetic behavior. Crucially, this approach is scalable—from lab-scale studies to industrial production. The ultimate goal is to enable a sustainable and flexible method for recycling end-of-life permanent magnets and producing custom magnetic components for automotive, energy, and electronic applications.