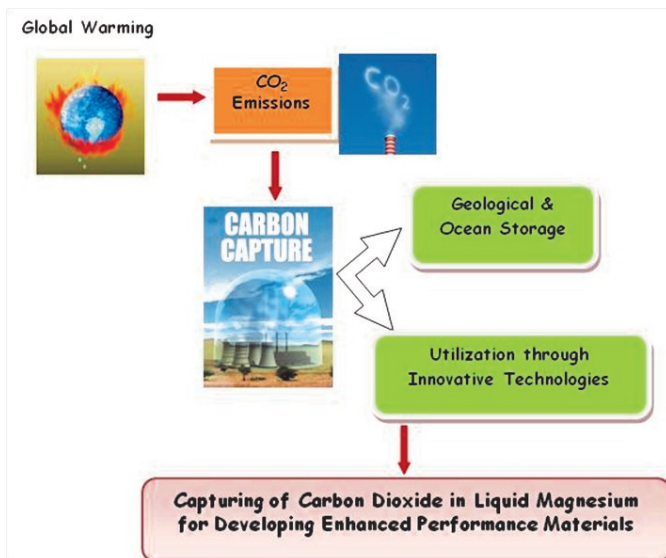


# Capturing of Carbon Dioxide in Liquid Magnesium for Developing Enhanced Performance Materials

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One of the biggest challenges being faced today is global warming induced climate change. One of the major sources contributing to the rapidly increasing temperatures on earth is the emission of carbon dioxide. Minerals, Metals and Materials Technology Centre (M3TC) is actively working to develop innovative technologies to capture and reutilize carbon dioxide from the atmosphere. The primary objective of this project is to capture carbon dioxide gas and reutilize it to develop enhanced performance Mg-based materials.



Magnesium alloys are one of the most versatile material choices amongst the structural materials that exhibit both energy efficiency and environmental benefits. However, as molten Mg is highly reactive, the casting processes for Mg-alloy production requires fluxes/protective gases, which emit greenhouse gases.

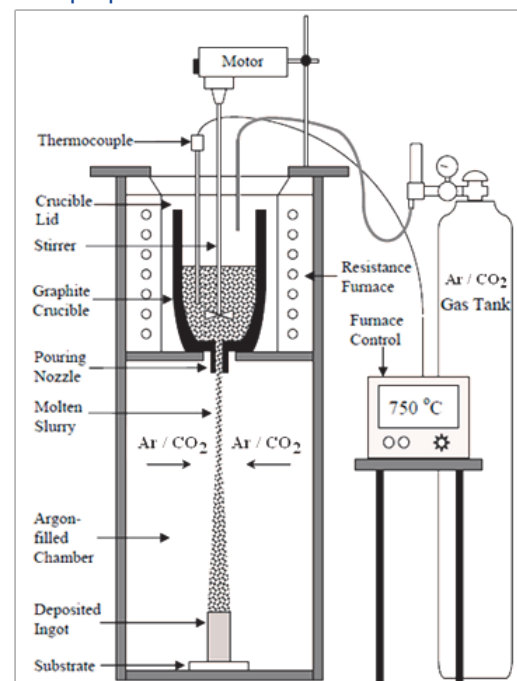
While use of 'environmental-friendly' cover gases is compelling, other novel solutions would include incorporation of green house gases such as CO<sub>2</sub> into the molten metal during metal casting, so as to ensure reutilization of the gas in a permanent way.

## Our Current Research

In the present research, the synthesis of magnesium based materials utilizing carbon dioxide is performed using a specially designed liquid-state synthesis technique known as the Disintegrated Melt Deposition (DMD) technique. Magnesium is used as the base metallic matrix with aluminum, zinc or other metallic elements as alloying constituents.

## Project Objectives

- To utilize CO<sub>2</sub> gas (a green house gas) during Mg-based alloy casting so as to promote eco-friendly materials processing.
- To produce Mg-based alloys in CO<sub>2</sub> atmosphere with enhanced properties.

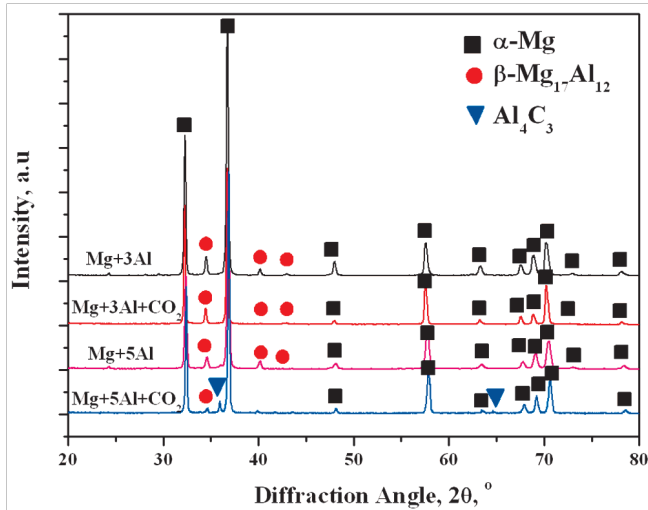


Schematic of the experimental set-up for casting Mg-alloys with CO<sub>2</sub> incorporation using DMD technique.

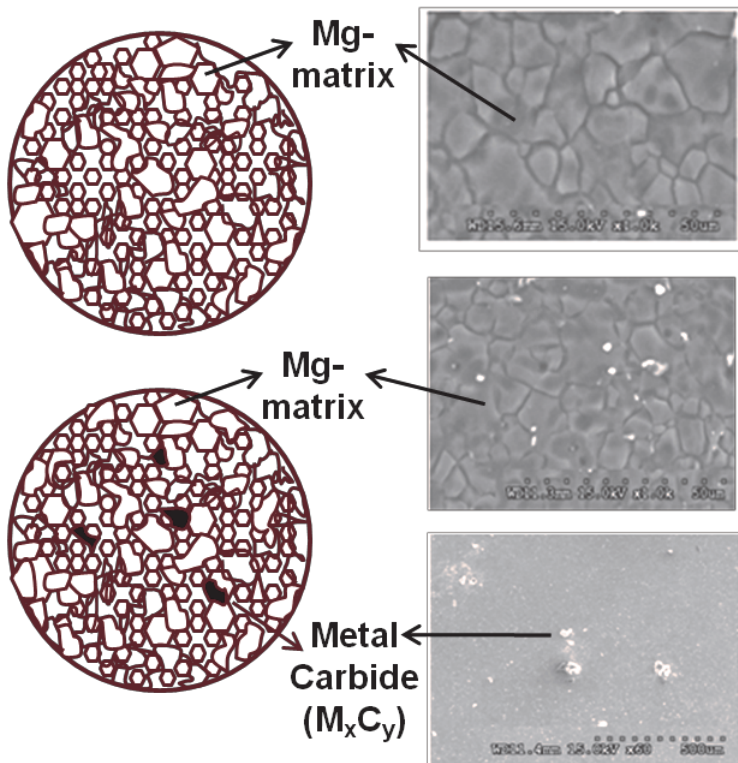
Based on the structure-property correlation of the cast and extruded alloys, the influence of CO<sub>2</sub> gas on the casting quality and material behavior can be ascertained.

## Microstructural Analyses

Characterization of Mg-based alloys processed in CO<sub>2</sub> atmosphere reveal utilization of carbon dioxide in the melt through the formation of metal carbide, while not increasing the grain size.



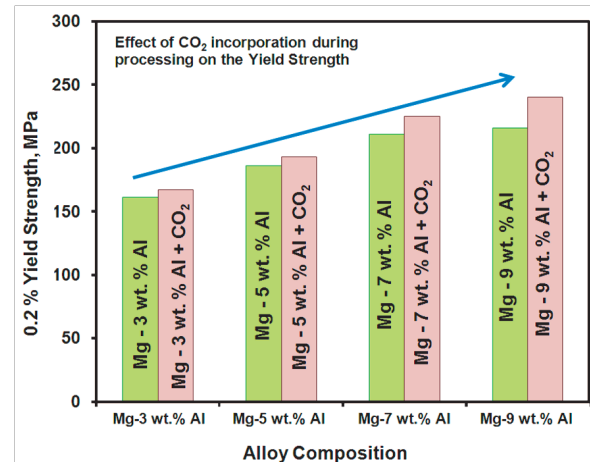
X-ray diffraction patterns of Mg-Al alloys without and with CO<sub>2</sub> processing, indicating the formation of metal carbides.



Microstructure of Mg-alloys with CO<sub>2</sub> processing indicate the formation of metal carbides. Note that the size of the grains are very small, ranging between ~5 to 10 μm, unachievable by conventional casting processes.

## Mechanical Properties

Evaluation of mechanical properties of the alloys processed with CO<sub>2</sub> incorporation, indicate increase in tensile yield and ultimate strengths. Under compression, improvement in compressive yield strength is observed. These improvements are attributed to the formation of metal carbides that act as dispersion strengtheners during mechanical loading.



Improvement in the tensile yield strength of the Mg-Al alloys due to CO<sub>2</sub> processing atmosphere, indicates the in situ reinforcement effect - an advantage due to CO<sub>2</sub> utilization.

## Industry Significance

The successful reutilization of CO<sub>2</sub> in Mg-alloy melts promises a potential eco-friendly processing technology with a considerable impact when extended to the industrial scale.

### Our Processing Facilities Include:

Liquid Metal Processing: DMD Casting Equipment  
 Secondary Processing: Extrusion Press  
 Powder Processing: Ball Mill, Microwave Sintering  
 Heat Treatment Furnaces, Glove Boxes

### Our Characterization Facilities Include:

Materials Testing Equipment (Tensile & Compression)  
 Materials Polishing Machines  
 X-Ray Diffractometer  
 Optical Microscopes  
 Scanning Electron Microscopes

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