4to Simposio interdisciplinario en materiales

Microstructural evolution and properties of Mg base alloys processed by severe plastic deformation

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INTRODUCTION

The interest in lighter and more resistant materials in the automotive industry, as well as the search for new materials for the storage of new fuels in the energy area has made Mg an element of great interest in recent years and this due to its characteristics:

- Low density: (1.74 g/cm^3)
- Low cost: ~ $ 8 - $ 10 per kilo
- Great abundance: 8th most abundant element
- Great potential in the energy area: (Storage of H2 / Hydrides Base Mg)

Disadvantages

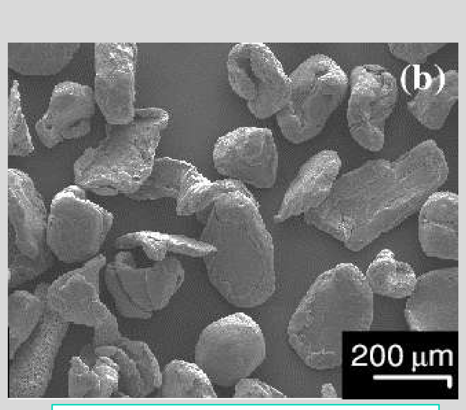
- Low mechanical properties
- Poor hardening mechanism
- High difficulty in production processes

Use of Mg alloys

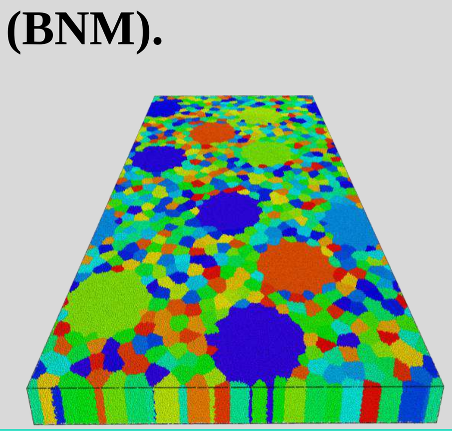
SEVERE PLASTIC DEFORMATION

SPD processes offer real alternatives to conventional routes to obtain Mg alloys, due the particle-particle interactions during plastic can be obtained at much lower temperatures. However, the available SPD techniques use monolithic materials as raw material, and little attention has been paid to the use of powders as starting material

- **In this work, high pressure torsion (HPT) is used to consolidate a powder mixture of Mg, Ni and Nb_2O_5 in order to produce bulk nanostructured materials (BNM).**



Magnesium powder



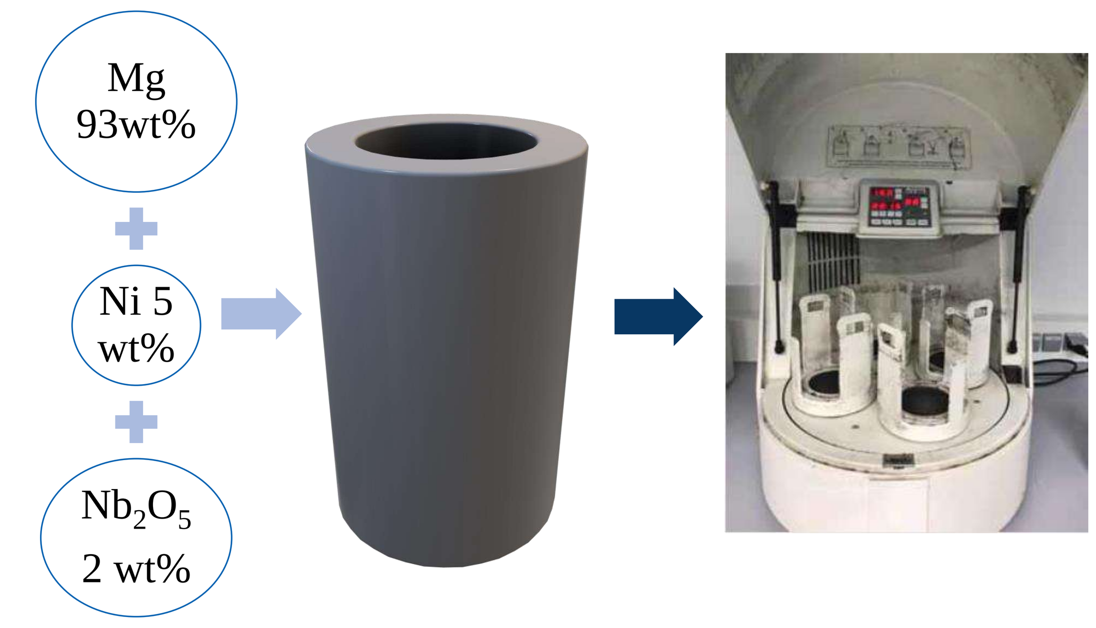
bulk nanostructured materials (BNM).

TARGET

- **Study the structure and properties in magnesium-based powder alloys produced (SPD), using (HPT).**
- **Produce ultrafine grain sizes (UFG) (100-500 nm) and nanometric (<100 nm), with magnesium-based powder alloys.**
- **This work it is intended to use raw materials as magnesium powders and different alloys with which it is possible to obtain diferent alloys of any desired composition**

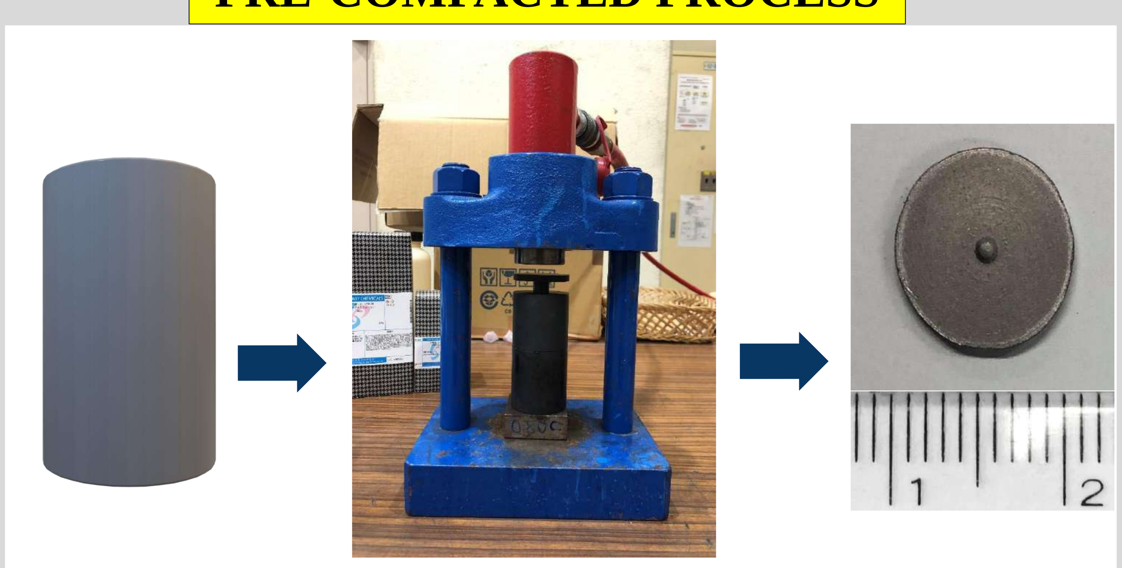
METHODS AND MATERIALS

MIXTURES



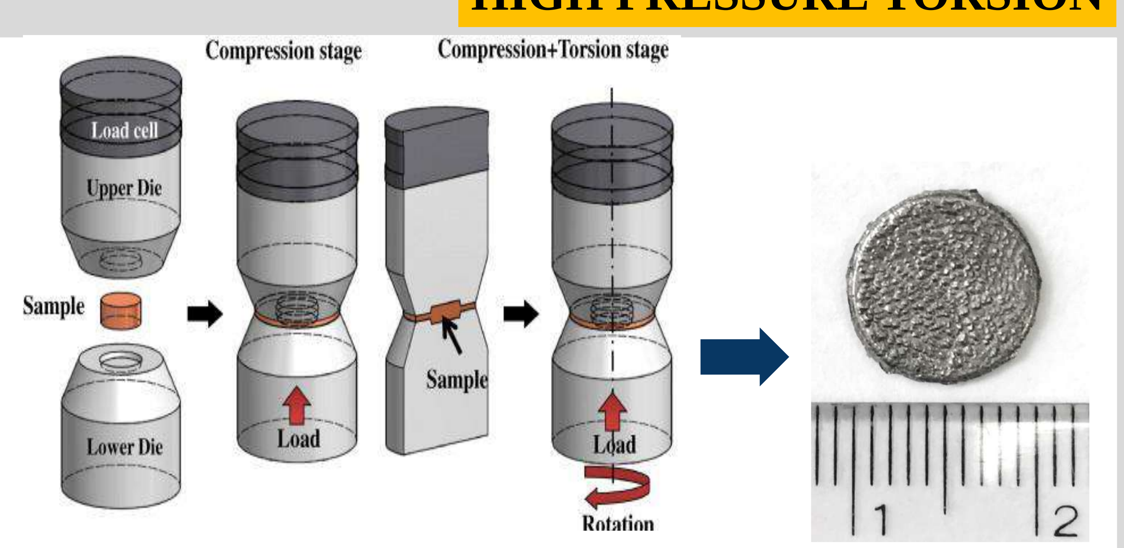
Mixing by mechanical milling For 1 hour

PRE-COMPACTED PROCESS



1) Filling 2) Compaction 3) Ejection

HIGH PRESSURE TORSION



Turns = 1, 5, 10, 20 y 30
Pressure = 3 y 5 GPa
Speed = 0.2 r.p.m

Diameter: 10 mm
Thickness: 1 mm

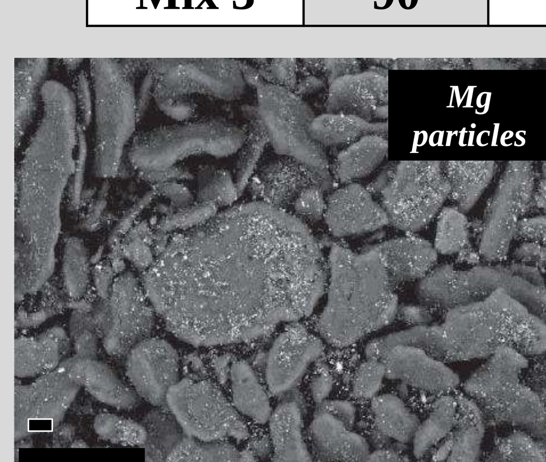
Characterization

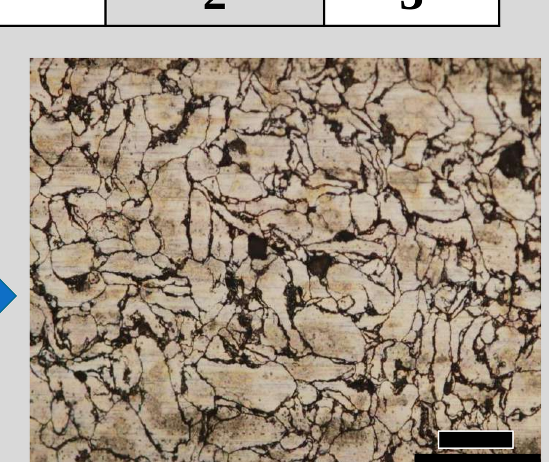
- Density measurements
- Phase identifications / X- Ray diffraction (XRD)
- Grain size and distribution of secondary phases/ Scanning electron microscopy (SEM-EBSD)
- transmission electron microscopy (TEM)
- Microhardness

RESULTS

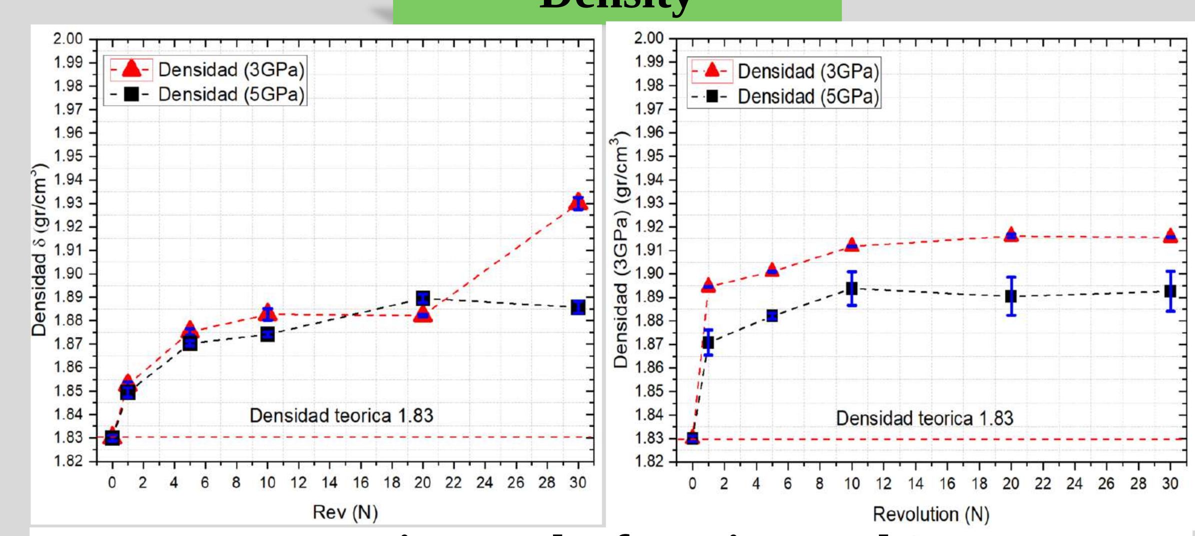
Powder mixture composition

Element	Mg	Ni	Nb_2O_5	NTC
Mix 1	93	5 (1 µm)	2	-
Mix 2	93	5 (100nm)	2	-
Mix 3	90	5	2	3





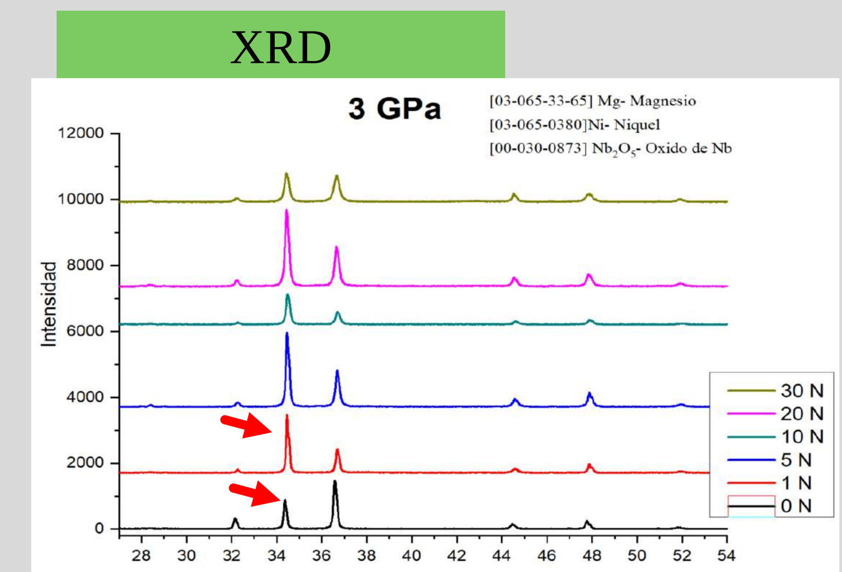
Density



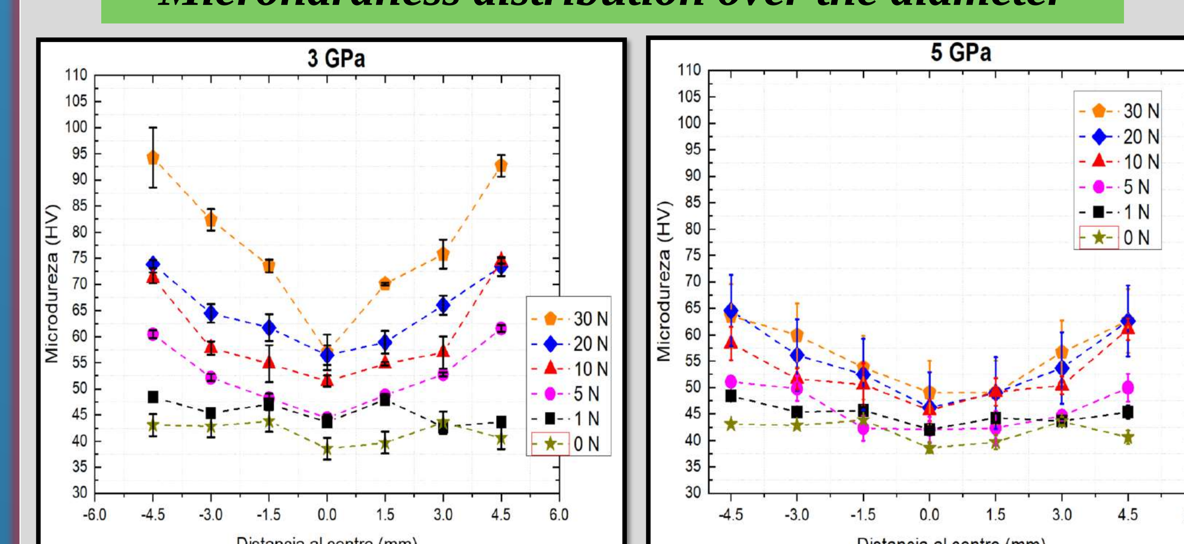
Density results for mix 1 and 2

XRD

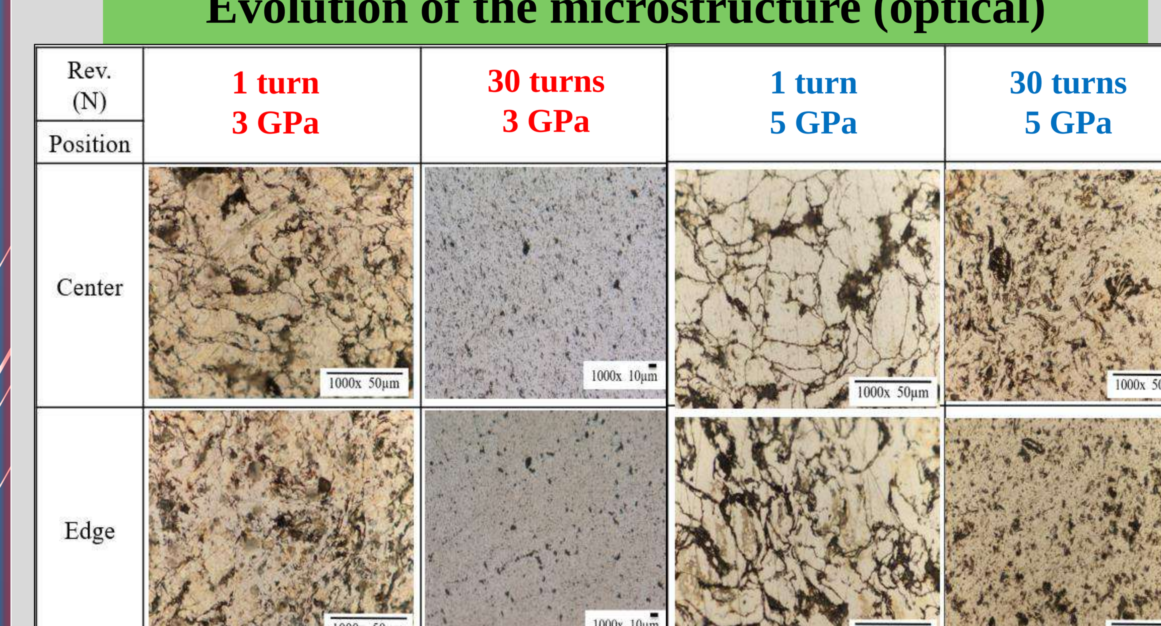
Introducing hign deformation a texture begins to form



Microhardness distribution over the diameter

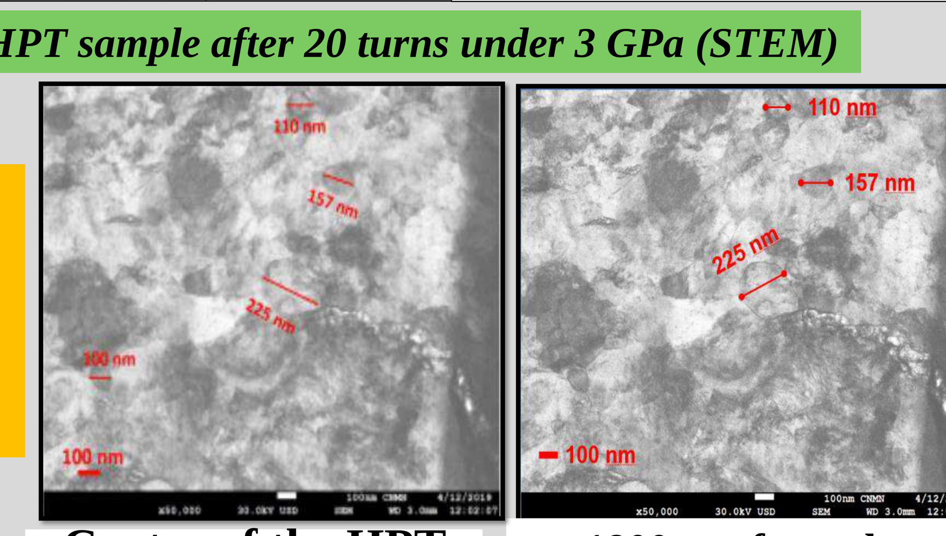


Evolution of the microstructure (optical)



HPT sample after 20 turns under 3 GPa (STEM)

Grain size in the range of 100 to 200nm



Center of the HPT disk
~1800 µm from the edge of the HPT disk

CONCLUSIONS

- The HPT process is highly effective in consolidating magnesium powders at room temperature.
- Microstructure and properties of the HPT samples are still inhomogeneous after 20 turns.
- Increasing the pressure by HPT, the microhardness values are more homogeneous, however its value decreases compared to a lower pressure.
- Finally, preliminary observations of the microstructure indicate a grain size of the order of 100 nm after 20 revs. which translates into the production of BNM by SPD with powder material was achieved.