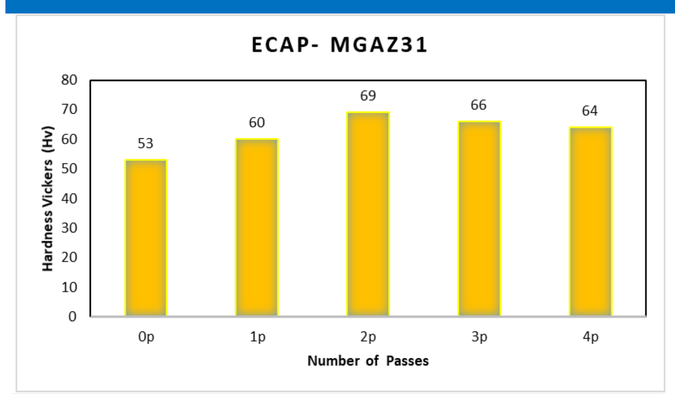
Doshisha University

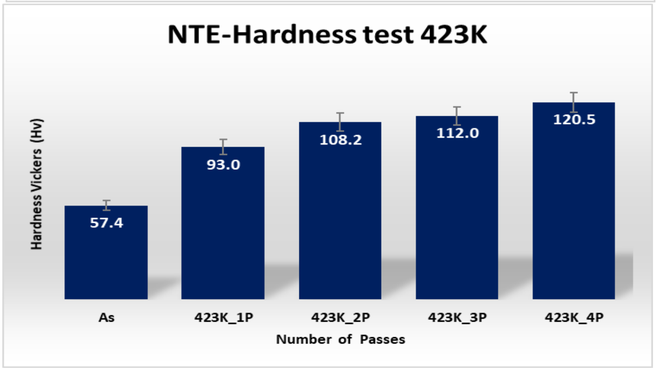
Improvement of the Mechanical Properties of Magnesium Alloy AZ31 Using Nonlinear Twist Extrusion (NTE)

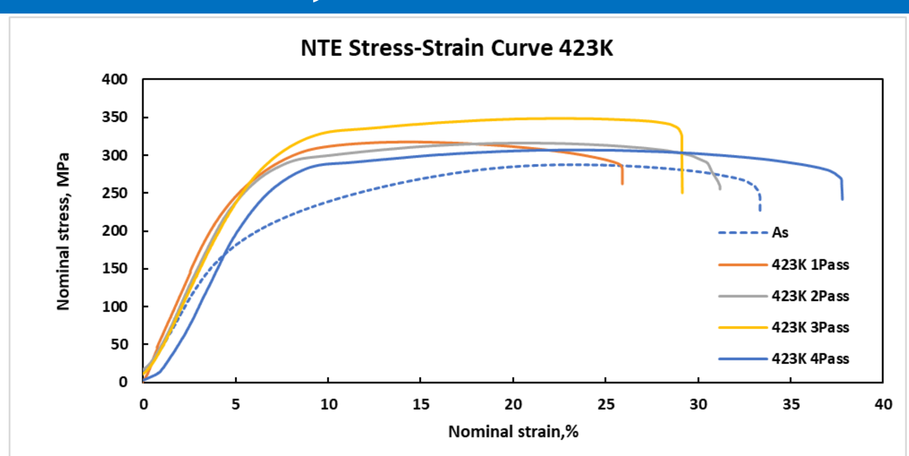
Research background

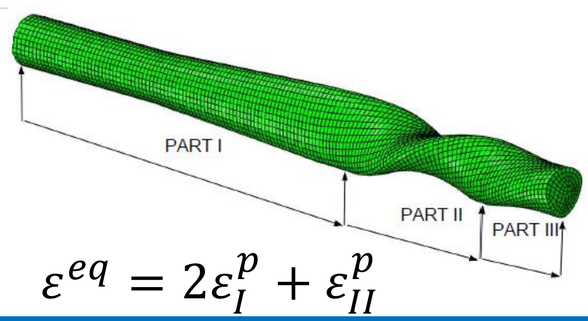
Magnesium alloys poses superior properties such as low density and high specific strength. However, its applications has been limited by their inferior cold workability. Mg-3%Al-1%Zn(AZ31) was subjected to severe plastic deformation(SPD) technique called nonlinear twist extrusion(NTE). Deformation was achieved for 4 passes at 373K,423K,473K,523K and 573K. Both microstructural and mechanical properties were examined.

Research results, Seeds and Technical overview

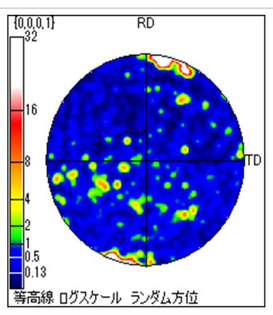








$$\varepsilon^{eq} = 2\varepsilon_I^p + \varepsilon_{II}^p$$



Tensile tests, Mpa

	NTE		ECAP	
	UTS	YS	UTS	YS
As	270	136	275	200
1 Pass	318	181	280	195
2 Pass	316	209	280	180
3 Pass	349	248	275	175
4 Pass	345	253	255	135

Hardness, Hv

	NTE	ECAP	HPT
As	57.4	53	55
1 Pass	93	60	N=1 85
2 Pass	108.2	69	
3 Pass	112	66	
4 Pass	120.5	64	N=5 70

Comparison with conventional technology

Deformation of Mg alloys through convectional SPD techniques such as ECAP at moderate temperatures below 473K has been unsuccessful due to cracks formation. However, AZ31 was successfully deformed through NTE at 373K without fractures. NTE achieves high grain refinement and dislocation accumulation since its geometry imposes plastic strains effectively and uniformly by minimizing rigid body rotation, strain localization and strain reversal.

Industrial effects

The demand for reliable, light and stiff materials in structural applications has been led to increased demand for Mg alloys. More so Mg alloys are expected to be useful for minimizing global environmental problems. Through inducing high plastic strains, NTE produces high strength materials which can be applied load carrying structures. AZ31 with improved mechanical properties is promising in automotive, aircraft fuselages, cell phones, laptop cases, speaker cones, healthcare amongst others.

Future tasks

Conduct experiment at room temperature and observe both the microstructures and mechanical properties. Redesign NTE die to increase equivalent plastic strains achieved. To investigate the effects of textures on both the tensile strength and hardness of the AZ31 alloy. The correlation between processing conditions and microstructures for various SPD method will be investigated.

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