Effects of Neodymium and Rotary Swaging on AZ71 Magnesium Alloys

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The current study discusses the development of microstructures and mechanical properties in AZ71 magnesium alloys with 0~2 wt.% additions of neodymium (Nd). Nd was found to suppress formation of β-$Mg_{17}Al_{12}$ phase, and addition of 1.0 wt.% of Nd yielded the most effective refinement effects on as-cast grains. Furthermore, 32% rotary swaging and subsequent 350˚C annealing processes reduced grain sizes substantially to below 30 μm. Nd strengths the alloys by solution and Al_xNd_y precipitation to bear tensile strength up to 253 MPa, while the elongation was increased to 10.7%, generating the best toughness combination in 1.0 wt.% Nd-added AZ71 alloy.

Keywords: AZ71 magnesium alloy, neodymium, rotary swaging, recrystallization

Results and Discussion

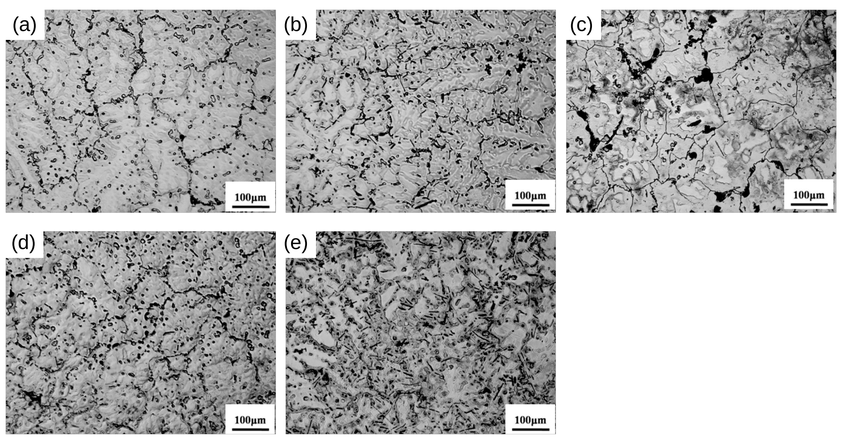

Fig 1. As-cast microstructures of AZ71 magnesium alloys with (a) 0, (b) 0.5, (c) 1.0, (d) 1.5, and (e) 2.0 wt.% Nd, respectively.

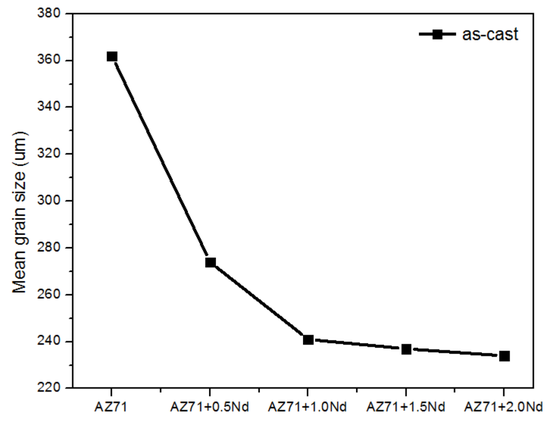

Fig 2. Variation of grain size in as-cast Nd-added AZ71 magnesium alloys.

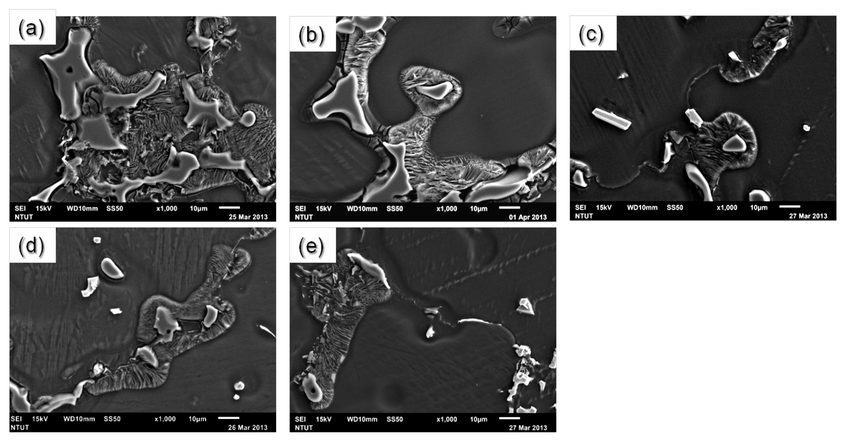

Fig 3. Observations of eutectic β-$Mg_{17}Al_{12}$ in AZ71 magnesium alloys with (a) 0, (b) 0.5, (c) 1.0, (d) 1.5, and (e) 2.0 wt.% Nd, respectively.

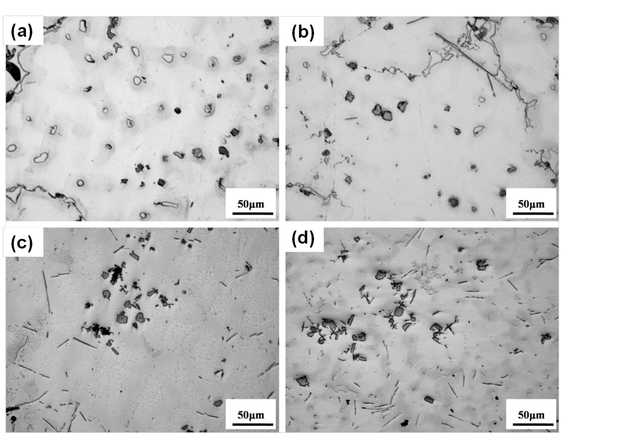

Fig 4. Observations of Al_xNd_y precipitates in as-cast AZ71 alloys with (a) 0.5, (b) 1.0, (c) 1.5, and (d) 2.0 wt.% Nd, respectively.

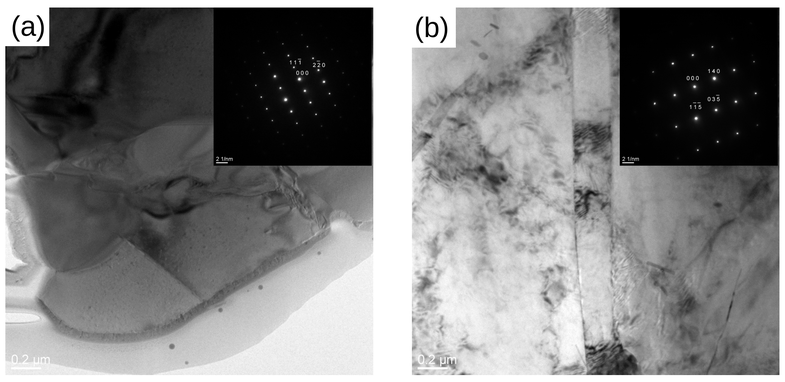

Fig 5. TEM images and SAED patterns along zone axis (a) [1 1 2] of Al_2Nd phase and (b) [20 5 3] of $Al_{11}Nd_3$ phase.

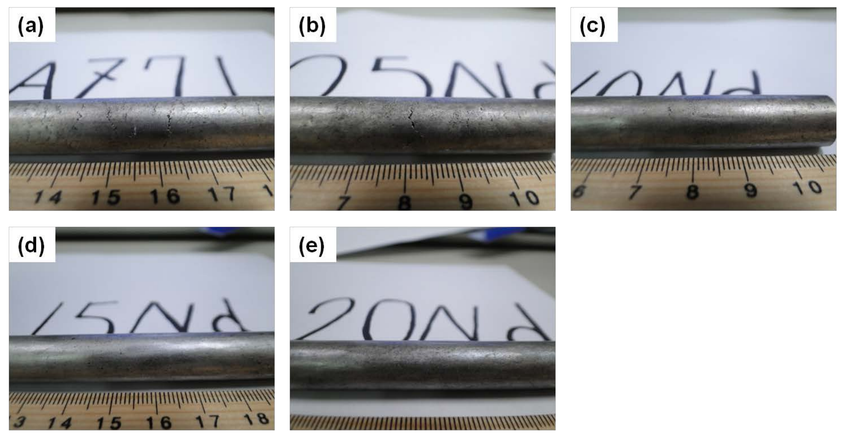

Fig 6. Surface observations of as-swaged AZ71 workpieces with (a) 0, (b) 0.5, (c) 1.0, (d) 1.5, and (e) 2.0 wt.% Nd, respectively.

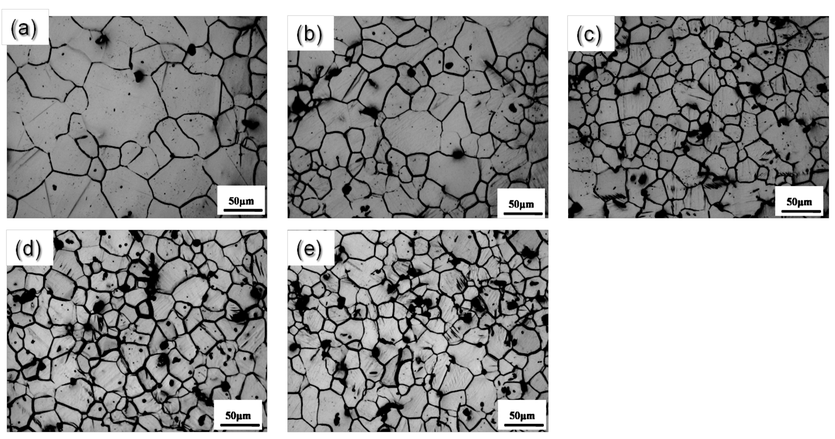

Fig 7. 32% rotary swaged and 350˚C annealed AZ71 magnesium alloys with (a) 0, (b) 0.5, (c) 1.0, (d) 1.5, and (e) 2.0 wt.% Nd, respectively.

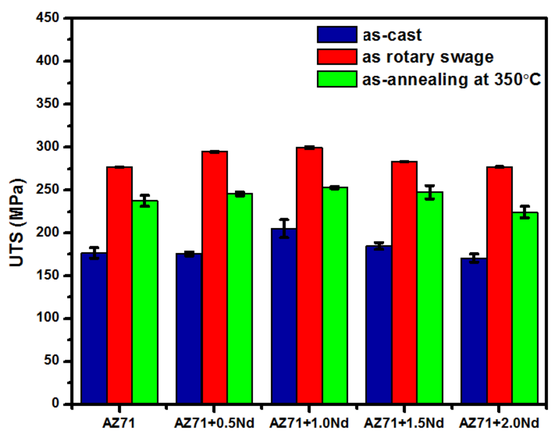

Fig 8. Tensile strength of Nd-added AZ71 alloys in as-cast, as-swaged, and 350˚C-annealed conditions.

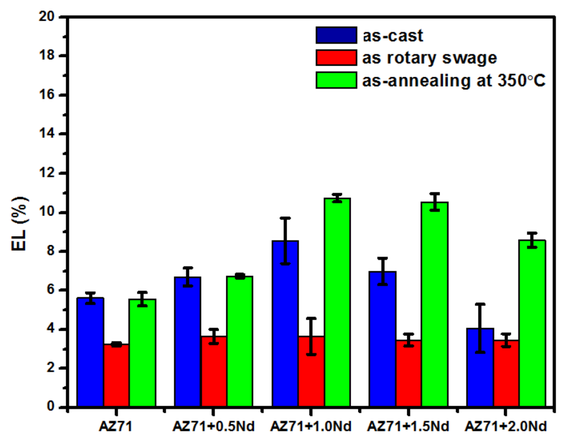

Fig 9. Elongation of Nd-added AZ71 alloys in as-cast, as-swaged, and 350˚C-annealed conditions.

Conclusion

- Grain size in as-cast AZ71 alloys decreased with Nd co -ntent. Nd also reduces the formation of eutectic phases. 1.0 wt.% Nd addition yield -ed the most effective grain re -finement effects. Rotary swaging and subsequent anne aling further reduced grain sizes to below 30 μm.
- Nd addition to AZ71 alloys provides strengthening mech -anisms through solid solution and Al_xNd_y precipitation s -trengthening. The Al_xNd_y could also benefits anti-creep performance of the alloys. With 1.0 wt.% of Nd, the distr -ibution and size of precipitation was found most uni -form without aggregates.
- 1.0 wt.% Nd addition and 32% rotary swaging followed by 350˚C annealing increased tensile strength to 253 MPa and ductility to 10.7%. AZ71 with Nd addition of 1.0 wt.% demonstrates the best toughness performance.