**Supplementary Information**

**Current progress of research on heat-resistant Mg alloys: A review**

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Table S1. The mechanical properties of Mg alloys at room temperatures and elevated temperatures.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Alloys | | States | Temperature / °C | UTS / MPa | YS / MPa | El / % | Strengthening phases | Ref. |
| Mg-Al | AZ31B | T5 | RT | 288 | 220 | 15 | β-Mg17Al12 | [1] |
| 260 | 75 | 31 | 75 |
| AZ91 | as-cast | RT | 193 | 105 | 3.2 | [2] |
| 150 | 179 | 99 | 2.9 |
| T6 | RT | 212 | 115 | 3.6 |
| 150 | 194 | 108 | 3 |
| AZ91+0.5Sn | as-cast | RT | 211 | 108 | 3.3 | β, Mg2Sn |
| 150 | 182 | 101 | 3.0 |
| T6 | RT | 222 | 115 | 3.6 |
| 150 | 198 | 110 | 5.1 |
| AZ91+0.5Sn+0.9Y | as-cast | RT | 229 | 115 | 3.7 | β, Mg2Sn, Al2Y |
| 150 | 192 | 107 | 4.2 |
| T6 | RT | 242 | 129 | 4.0 |
| 150 | 211 | 119 | 5.9 |
| AZ91+0.4Sn | extruded | RT | 326 | 246 | 16 | β, Mg2Sn | [3] |
| 200 | 116 |  | 149 |
| Mg-Al-Ca | AZ91 | as-cast | RT | 170.9 | 108.9 | 3.9 | β | [4] |
| 150 | 134.8 | 102.6 | 4.3 |
| 200 | 126.7 | 93.4 | 12.9 |
| T6 | RT | 212 | 149.5 | 3.3 |
| 150 | 171.7 | 96.1 | 7.5 |
| 200 | 126.4 | 85.7 | 14 |
| AZ91+0.3Ca | as-cast | RT | 173.2 | 112.4 | 3.6 | β, Mg2Ca, Al2Ca |
| 150 | 139.4 | 106 | 4 |
| 200 | 131.4 | 97.9 | 9.8 |
| T6 | RT | 220.1 | 152.2 | 4.9 |
| 150 | 176 | 120.6 | 4.4 |
| 200 | 133.2 | 104.3 | 6.1 |
| AZ91+0.3Ca+1.0RE | as-cast | RT | 186.9 | 135.3 | 4 | β, Mg2Ca, Al2Ca, Al11RE3 |
| 150 | 153.3 | 124.4 | 5.4 |
| 200 | 140.6 | 108.3 | 11 |
| T6 | RT | 239.1 | 160.3 | 5.1 |
| 150 | 200.7 | 146.8 | 8.7 |
| 200 | 167.8 | 137.6 | 11 |
| Mg-6Al | as-cast | 175 | 104.5 |  | 11 | β | [5] |
| 200 | 71.3 |  | 24 |
| 225 | 60.8 |  | 43 |
| Mg-6Al-4Ca | as-cast | 175 | 135.7 |  | 6.5 | Al2Ca,  (Mg, Al)2Ca |
| 200 | 122.1 |  | 12 |
| 225 | 91.5 |  | 19 |
| Mg-6Al-4Sm | as-cast | 175 | 125.3 |  | 7.4 | β, Al2Sm |
| 200 | 111.6 |  | 25 |
| 225 | 102.5 |  | 42 |
| Mg-6Al-2Ca-2Sm | as-cast | 175 | 157.2 |  | 13.7 | Al2Ca, (Mg, Al)2Ca, Al2Sm |
| 200 | 134.4 |  | 15.7 |
| 225 | 118.8 |  | 31.7 |
| Mg-5Al-3Ca | extruded | 150 | 160.5 |  | 35.3 | Al2Ca, (Mg, Al)2Ca, Al2Nd | [6] |
| Mg-5Al-3Ca-3Nd | extruded | 150 | 170.6 |  | 31.1 |
| Mg-Al-RE | Mg-8Al-2Sr | as-cast | 175 | 123.8 | 90 | 4.5 | β, Al4Sr | [7] |
| Mg-8Al-2Sr-0.12Y | as-cast | 175 | 187.5 | 116.3 | 6.2 | Al4Sr, Al2Sr, Al2Y |
| Mg-8Al-2Sr-0.36Y | as-cast | 175 | 203.8 | 158.8 | 8.2 |
| Mg-4Al-4 (La, Ce) | die-casting | RT | 250.1 | 132.3 | 15.4 | Al11RE3 | [8] |
| 200 | 108.3 |  | 19.4 |
| 250 | 91.5 |  | 13.3 |
| 300 | 74.6 |  | 16.4 |
| Mg-4Al-4 (La, Ce)-2Sm | die-casting | RT | 242 | 135.5 | 10.9 | Al11RE3, Al2RE |
| 200 | 111.1 |  | 23.5 |
| 250 | 95.2 |  | 19.1 |
| 300 | 78.2 |  | 20.8 |
| AE44 | as-cast | 150 | 140 | 109 | 27 | Al11RE3 |
| ALaSm432 | as-cast | 155 | 120 | 25 |
| AEX422 | as-cast | 199 | 148 | 9 |  |
| HP2+ | die-casting | RT | 173 | 145 | 1.5 | Mg-RE | [9] |
| 150 | 139 | 120 | 5.9 |
| 250 | 110 | 96 | 21 |
| 300 | 82 | 78 | 22.2 |
| Mg-5RE (La,Ce,Nd,Gd) -Al | die-casting | RT | 197 | 170 | 2.3 | Al-RE, Mg12REZn0.39Al0.13 |
| 150 | 160 | 141 | 7.7 |
| 250 | 126 | 113 | 26.9 |
| 300 | 98 | 94 | 27.1 |
| Mg-Zn | Mg-6Zn-2Al-0.2Mn | as-cast | RT | 190 | 101 | 8.5 | Mg(Zn, Al), MgZn | [10] |
| 150 | 150 | 73 | 14.5 |
| Mg-6Zn-2Al-0.2Mn  -0.5Sn | as-cast | RT | 225 | 118 | 8.9 | MgZn, Mg2Sn |
| 150 | 212 | 113 | 12.2 |
| Mg-4Zn-4Al | as-cast | RT | 160 | 74 | 4.2 | Al2Mg5Zn2 | [11] |
| 175 | 107 | 66 | 4.5 |
| Mg-4Zn-4Al-2La-2Ca | as-cast | RT | 212 | 82 | 5.2 | Al2LaZn2, Al4Ca, Ca2Mg6Zn3 |
| 175 | 141 | 70 | 7.1 |
| Mg-4Zn | as-cast | RT (shear) | 110 |  |  | Mg7Zn3 | [12] |
| 150 (shear) | 94.2 |  |  |
| 200 (shear) | 74.8 |  |  |
| Mg-4Zn-2Y | as-cast | RT (shear) | 141.3 |  |  | Mg7Zn3, Mg3Zn3Y2 |
| 150 (shear) | 139.4 |  |  |
| 200 (shear) | 134.8 |  |  |
| Mg-3Zn-1Y | extruded | 250 | 151 | 137 | 127.2 | W-phase | [13] |
| Mg-3Zn-1Y-0.9Sr | extruded | 250 | 204 | 168 | 61.3 | W-phase,  S-phase (Mg6Zn2Sr) |
| Mg-6Zn-1Mn-4Sn  -0.5Y | T6 | RT | 376 | 371 | 7.7 | α-Mn, MgZn2, Mg2Sn, MgSnY | [14] |
| 150 | 305 | 277 | 16.7 |
| 200 | 285 | 247 | 18.3 |
| 250 | 201 | 178 | 21.6 |
| 300 | 150 | 136 | 25.5 |
| Mg-(Ce group) | Mg-1.6La-1Ce | as-cast | RT | 189.9 | 135.6 | 3.8 | Mg12(La, Ce) | [15] |
| 200 | 98.3 | 86.6 | 15.5 |
| 300 | 57.4 | 56.3 | 19.1 |
| Mg-1.6La-1Ce-0.5Nd | as-cast | RT | 178.9 | 139.3 | 2.7 | Mg12(La, Ce, Nd) |
| 200 | 103.5 | 90.5 | 23.5 |
| 300 | 71.7 | 69.4 | 30.3 |
| Mg-1.6La-1Ce-1Nd | as-cast | RT | 170.2 | 145.5 | 1.6 | Mg12(La, Ce, Nd) |
| 200 | 110.8 | 97.2 | 20.8 |
| 300 | 80.5 | 77.8 | 28.7 |
| Mg-1.6La-1Ce-2Nd | as-cast | RT | 174.5 | 153.9 | 1.1 | Mg12(La, Ce, Nd), Mg41Nd5 |
| 200 | 115.1 | 103.3 | 18.9 |
| 300 | 85.7 | 83.6 | 26.7 |
| Mg-1.6La-1Ce-3Nd | as-cast | RT | 181.9 | 161.9 | 0.7 | Mg12(La, Ce, Nd), Mg41Nd5 |
| 200 | 120.6 | 109.2 | 17.1 |
| 300 | 91.4 | 90.4 | 20.3 |
| Mg-0.45La-0.63Nd (at.%) | as-cast | 177 | 175.9 | 126.6 | 5.7 |  | [16] |
| T4 | 177 | 191.1 | 134.2 | 6.5 | Nd-rich precipitates (β1 or β') |
| T6 | 177 | 201 | 144.7 | 11.5 |
| Mg-0.45La-0.87Gd (at.%) | as-cast | 177 | 192.8 | 126.6 | 2.4 |  |
| T4 | 177 | 205.1 | 140.1 | 5.4 | β' |
| T6 | 177 | 242.5 | 208.3 | 10.1 |
| Mg-0.45La-1.18Y (at.%) | as-cast | 177 | 205.7 | 134.8 | 5.3 |  |
| T4 | 177 | 219.1 | 150.6 | 5.7 | β' |
| T6 | 177 | 248.3 | 177.4 | 9.2 |
| Mg-2.5Nd-0.5Zn-0.5Zr | extruded | 150 | 219.1 | 182.1 | 39.4 |  | [17] |
| 200 | 199.4 | 168.5 | 36.3 |
| 250 | 191.5 | 154.5 | 30.1 |
| 300 | 173.3 | 140.5 | 47.6 |
| Mg-Y | Mg90.5Zn3.25Y6.25 | hot rolling  +annealing | RT | 400 | 353 | 5 | LPSO | [1] |
| 250 | 375 | 279 | 14 |
| 325 | 145 | 131 | 34 |
| 350 | 88 | 70 | 57 |
| Mg97Y2Zn1 | extruded | RT | 333.1 | 201.4 | 10.9 | 14H-LPSO, Mg24Y5 | [18] |
| 200 | 248 | 147.6 | 18.2 |
| 300 | 202.4 | 138.5 | 47.6 |
| Mg96Y3Zn1 | extruded | RT | 349.3 | 211.5 | 4.8 |
| 200 | 322 | 181.1 | 12.5 |
| 300 | 234.8 | 161.8 | 44.8 |
| Mg95Y4Zn1 | extruded | RT | 367.6 | 230.7 | 0.9 |
| 200 | 339.2 | 203.4 | 7.3 |
| 300 | 261.2 | 175 | 27.2 |
| Mg-0.8Zn-0.35Zr | gravity casting | RT | 179.9 |  | 21.5 |  | [19] |
| 175 | 100.6 |  | 34.5 |
| 200 | 83.8 |  | 35 |
| 250 | 50.3 |  | 52.9 |
| Mg-0.8Zn-1Y-0.35Zr | gravity casting | RT | 206.6 |  | 26 | Mg24Y5 |
| 175 | 150.9 |  | 32.7 |
| 200 | 141 |  | 34.2 |
| 250 | 127.3 |  | 34.8 |
| Mg-0.8Zn-2Y-0.35Zr | gravity casting | RT | 205.8 |  | 22.9 | LPSO, Mg24Y5 |
| 175 | 167.7 |  | 29.5 |
| 200 | 163.9 |  | 30.4 |
| 250 | 158.5 |  | 31.8 |
| Mg-0.8Zn-3Y-0.35Zr | gravity casting | RT | 206.6 |  | 22.2 | LPSO, Mg24Y5 |
| 175 | 174.5 |  | 26 |
| 200 | 170 |  | 27.5 |
| 250 | 166.9 |  | 31.8 |
| Mg-Gd | Mg-15Gd | as-cast | RT | 158.6 | 116.2 | 2.5 | Mg5Gd | [20] |
| 260 | 133.2 | 100.5 | 3.3 |
| 300 | 120.3 | 87.5 | 5.8 |
| T4 | RT | 147.1 | 105.6 | 6.7 | β' |
| 260 | 121.3 | 93.5 | 7.9 |
| 300 | 100.7 | 82.4 | 12.5 |
| T6 | RT | 186.6 | 183.3 | 0.9 | β', β1, Mg5Gd |
| 260 | 162.5 | 142.2 | 1.7 |
| 300 | 123.8 | 120 | 3.5 |
| Mg-2Gd-3Zn | as-cast | RT | 216.5 | 93.4 | 10 | W (Mg3Zn3Gd2) | [21] |
| 175 | 150.5 | 75.9 | 22.8 |
| Mg-8Gd-0.4Zr | extruded-T5 | RT | 253 | 171 | 12 | β' | [22] |
| 150 | 228 | 136 | 14 |
| 200 | 218 | 134 | 16 |
| Mg-8Gd-1Zn-0.4Zr | extruded-T5 | RT | 314 | 217 | 17 | β', β1, LPSO,  W (Mg3Zn3Gd2) |
| 150 | 284 | 194 | 20 |
| 200 | 248 | 171 | 26 |
| WE | WE54 | T6 | RT | 275 | 200 | 5 | β' (Mg12NdY),  β (Mg14Nd2Y) | [1] |
| 250 | 225 | 170 | 7.5 |
| WE54 | extruded-T5 | RT | 330.5 | 298.2 |  |  | [23] |
| 150 | 304.9 | 261.9 |  |
| 200 | 264.6 | 244.5 |  |
| 250 | 196.1 | 124.9 |  |
| WE43 | T6 | 200 | 248.9 | 182 |  | β' (Mg12NdY),  β (Mg14Nd2Y) | [24] |
| 250 | 231.2 | 174.3 |  |
| 300 | 173.9 | 134.3 |  |
| Mg-4Y-3Nd-0.5Zr | T6 | 200 | 269.9 | 195.6 | 18.1 |
| 250 | 264.7 | 189.1 | 20.3 |
| 300 | 245.8 | 173.9 | 23.8 |
| Mg-5Y-3Nd-Zr | as-cast | RT | 180 | 161 | 3.7 | β-Mg14Nd2Y, Mg24RE5 | [25] |
| 250 | 157 | 101 | 6 |
| Mg-5Y-3Nd-2Gd-Zr | as-cast | RT | 220 | 142 | 17.7 | β-Mg14Nd2Y, Mg5RE, Mg24RE5 |
| 250 | 194 | 101 | 17 |
| Mg-5Y-3Nd-4Gd-Zr | as-cast | RT | 186 | 130 | 9.7 |
| 250 | 199 | 128 | 10.1 |
| Mg-Gd-Y | Mg-3Gd-3Y-0.5Zr | T6 | RT | 185.1 | 105.4 | 14.6 | Mg5(Gd, Y), Mg24Y5 | [26] |
| 200 | 176.2 | 89.3 | 21.8 |
| 250 | 160.2 | 85.7 | 23.3 |
| 300 | 96.2 | 71.4 | 51.1 |
| Mg-6Gd-3Y-0.5Zr | T6 | RT | 311.2 | 221.5 | 3.9 | β', Mg5(Gd, Y), Mg24Y5 |
| 200 | 259.6 | 191.1 | 11.4 |
| 250 | 234.8 | 173.2 | 14.4 |
| 300 | 138.8 | 91.1 | 36.2 |
| Mg-10Gd-3Y-0.5Zr | T6 | RT | 362.7 | 237.5 | 3 | β', Mg5(Gd, Y), Mg24Y5 |
| 200 | 325.3 | 221.5 | 8.4 |
| 250 | 293.4 | 212.5 | 11.1 |
| 300 | 176.2 | 137.5 | 19.7 |
| Mg-12Gd-3Y-0.5Zr | T6 | RT | 373.4 | 244.6 | 2.1 | β', Mg5(Gd, Y), Mg24Y5 |
| 200 | 339.6 | 233.9 | 7.5 |
| 250 | 312.9 | 232.2 | 9 |
| 300 | 197.5 | 176.8 | 17.9 |
| Mg-10Gd-5Y-0.5Zr | T6 | RT | 302 | 289 | 3 | β', Mg5(Gd, Y) | [27] |
| 175 | 320 | 262 | 3.1 |
| 250 | 340 | 267 | 5 |
| 300 | 310 | 234 | 10.1 |
| Mg-9Gd-3Y-0.5Zr | extruded | RT | 380 | 327 | 8.9 |  | [28] |
| 250 | 351 | 325 | 11.6 |
| 300 | 203 | 187 | 27.9 |
| Mg-10Gd-3Y-0.5Zr | extruded-T5 | RT | 397 | 311 | 5 | Mg5RE, Mg24RE5 | [23] |
| 200 | 362 | 253 | 15.5 |
| 250 | 308 | 190 | 33 |
| 300 | 157 | 93 | 105.1 |
| Mg-10Gd-3Y-1Zn  -0.5Zr | extruded-T5 | RT | 428 | 339 | 4 | Mg5RE, Mg24RE5, Mg4Zn7, β' |
| 200 | 373 | 270 | 19.1 |
| 250 | 323 | 202 | 34.3 |
| 300 | 183 | 101 | 108.9 |
| Mg-8.2Gd-3.8Y-1Zn-0.4Zr | extruded | RT | 378 | 303 | 17 | 14H-LPSO | [29] |
| 100 | 355 | 290 | 18 |
| 250 | 322 | 264 | 19 |
| 300 | 284 | 245 | 25 |
| extruded-T5 | RT | 470 | 395 | 8 | 14H-LPSO, β' |
| 100 | 464 | 380 | 12 |
| 250 | 399 | 328 | 13 |
| 300 | 311 | 271 | 19 |
| Mg-8Gd-3Y-1Zn  -0.3Zr | extruded | RT | 341 | 270 | 11.9 | LPSO, β, SFs | [30] |
| 250 | 316 | 260 | 19 |
| 300 | 272 | 253 | 28.9 |
| Mg-6Gd-5Y-1Zn  -0.3Zr | extruded | RT | 359 | 302 | 10.2 |
| 250 | 338 | 289 | 16.2 |
| 300 | 286 | 275 | 30.1 |
| Mg-4Gd-7Y-1Zn  -0.3Zr | extruded | RT | 339 | 299 | 3.9 |
| 250 | 328 | 282 | 10.8 |
| 300 | 230 | 223 | 38.9 |
| Mg-11Gd-5Y-2Zn  -0.7Zr | extruded | RT | 365 | 278 | 12.6 | LPSO, β, SFs | [31] |
| 250 | 342 | 271 | 17.1 |
| 300 | 337 | 275 | 20.8 |
| 350 | 278 | 248 | 27.6 |
| Mg-9Gd-3Y-0.6Zn  -0.4Zr | extruded | RT | 372 | 345 | 5.8 | LPSO, Mg5RE | [32] |
| 250 | 317 | 304 | 9.4 |
| extruded-T5 | RT | 445 | 432 | 1.6 | LPSO, β' |
| 250 | 338 | 328 | 6.2 |
| Mg-9Gd-3(RY)  -0.6Zn-0.4Zr | extruded | RT | 421 | 385 | 10.6 | LPSO, Mg5RE |
| 200 | 385 | 341 | 7.2 |
| 250 | 334 | 320 | 10.8 |
| 300 | 258 | 236 | 13.1 |
| extruded-T5 | RT | 490 | 481 | 2.1 | LPSO, γ'', β' |
| 200 | 405 | 388 | 4.2 |
| 250 | 395 | 350 | 4.3 |
| 300 | 310 | 272 | 12.6 |
| Mg-2Gd-1.2Y-0.5Zn-0.15Zr (at.%) | extruded-T5 | RT | 469 | 419 | 7.6 | LPSO, β' | [33] |
| 200 | 391 | 359 | 12.7 |
| 250 | 296 | 277 | 22.4 |
| Mg-11Gd-4Y-1Zn  -0.3Mn | extruded-T5 | RT | 508 | 454 | 3.2 | thinner LPSO, γ', β' |
| 200 | 450 | 404 | 4.6 |
| 250 | 361 | 330 | 11.4 |
| Mg-7Gd-4Y-1Zn  -0.5Mn | extruded-T5 | RT | 487 | 420 | 4.9 | LPSO, β, β',  RE/Zn segregated SFs | [34] |
| 250 | 299 | 273 | 19.1 |
| 300 | 176 | 124 | 50.4 |
| Mg-10Gd-2Y-1Zn  -0.5Mn | extruded-T5 | RT | 493 | 442 | 3.1 |
| 250 | 335 | 328 | 18.8 |
| 300 | 168 | 129 | 53.3 |
| Mg-14Gd-1Zn-0.5Mn | extruded-T5 | RT | 464 | 386 | 6.2 |
| 250 | 293 | 262 | 25.3 |
| 300 | 148 | 112 | 48.4 |
| Mg-14Gd-2Y-1Zn-0.5Mn | extruded-T5 | RT | 520 | 448 | 3.5 |
| 250 | 344 | 322 | 18.8 |
| 300 | 225 | 196 | 38.6 |
| Mg-8Gd-2Y-1Nd  -0.3Zn-0.6Zr | extruded | RT | 271 | 143 | 18.7 | Mg5RE, Mg24RE5 | [35] |
| 200 | 233 | 134 | 20.1 |
| 300 | 188 | 121 | 44 |
| extruded-T5 | RT | 376 | 270 | 14.2 | β', Mg5RE, Mg24RE5 |
| 200 | 301 | 208 | 17.2 |
| 300 | 206 | 153 | 25.4 |
| Mg-11Gd-4.5Y-1Nd-1.5Zn-0.5Zr | extruded | RT | 377 | 327 | 3.8 | Mg5RE, LPSO | [36] |
| 200 | 357 | 290 | 5 |
| 250 | 286 | 268 | 10.5 |
| 300 | 193 | 172 | 54.4 |
| extruded-T5 | RT | 473 | 373 | 4.1 | LPSO, γ′, β' |
| 200 | 405 | 343 | 4.2 |
| 250 | 369 | 316 | 6.3 |
| 300 | 232 | 212 | 35.7 |
| Mg-Er | Mg-4Er-2Y-3Zn  -0.4Mn | extruded | RT | 351.2 | 319.1 | 7.0 | LPSO, W, SFs | [37] |
| 200 | 332.8 | 303.5 | 12.2 |
| 250 | 310.8 | 287.8 | 14.6 |
| 300 | 264 | 251.2 | 23.9 |
| Mg-6Er-3Y-1.5Zn  -0.4Mn | extruded | RT | 354 | 316 | 8.1 | LPSO, SFs | [38] |
| 200 | 336 | 298 | 11.7 |
| 250 | 326 | 285 | 14.5 |
| 300 | 301 | 274 | 17.3 |
| Mg-4Er-2Nd-0.6Zn  -0.2Zr | extruded | RT | 418.9 | 380 | 7.8 | Mg3RE, SFs | [39] |
| 200 | 373.3 | 350 | 12.0 |
| 250 | 347.8 | 335.6 | 14.7 |
| 300 | 260 | 242.2 | 22.3 |

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