HRTEM tracking of microstructure in hydrogen charged and aged 7xxx aluminum alloys

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To reduce the emission of greenhouse gases is becoming imperative to progress towards technologies powered by renewable energy sources. Hydrogen offers one of the greatest potentials. Abundant and three times more potent than gasoline, it is being researched as an alternative source to fuel from nuclear fusion reactors to rocket spaceships. A better understanding of hydrogen effect on metallic alloys is required. Al alloys are increasingly being used as the main building material in different parts of transportation vehicles. 7xxx Al series are one of the most used series of extruded Al alloys.

In this work, the samples with basic composition Al - 3.4at. %Zn -1.9at. %Mg were solid solution at 475°C for 1h, quenched into iced water, left 4 days to natural age and were then final aged at 120°C. To introduce hydrogen, samples were cut immediately after quenching in an electrical discharge machine. The effect of hydrogen on the mechanical properties and microstructures were studied during artificial ageing using micro vickers hardness measurements and transmission electron microscopy (TEM). The Vickers microhardness tests used a 0.98N load for holding time 15 seconds in a Mitutoyo HM-101. Every value is based on twenty indentations and only ten most common values were taken into account. Specimens for TEM observation were prepared using standard method of twin-jet polishing in a Struers Tenupol-3, using 1/3 nitric acid and 2/3 methanol kept at temperature of -25°C and 14V tension.

High resolution TEM observation of microstructure evolution was carried out mainly under $[110]_{Al}$ zone axis. A considerable higher density of GPII zones were counted in hydrogen charged samples compared to hydrogen free ones where these zones were almost absent. So-called GPII zones were observed even in slightly overaged condition.
These zones are believed to nucleate on vacancy-rich solute clusters that are formed on $\{111\}_{Al}$ planes [1]. This necessitates an increased presence of vacancies. Observation of this phenomena may confirm the reduction of vacancy formation energy because of hydrogen atoms trapped inside them [2,3,4].

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