Magnesium nitride phase formation through new ion beam implantation technique

Magnesium alloys are interesting for industries where weight gain is the priority; unfortunately, their poor corrosion resistance has delayed its use in many industrial sectors. Particularly with regard to automotive applications, surface modifications become indispensable. On the other hand the mechanical properties of magnesium are close to that of human bones and it is of great importance for our body. This suggests the use of Mg alloys for implants or stents with tailored degradation properties to avoid additional surgeries.

With respect to technical issues e.g. in automotive industries, nitriding of magnesium by nitrogen ion implantation applying the Hardion+ technology has been carried out on well known compounds. The treatments have been studied for their corrosion resistance enhancement, the involved phase formation and the changes of mechanical properties on common Mg- based alloys (bare, AM50, AZ31). Nitrogen ions with an energy of approximately 100 keV were used to induce the formation of the Mg_3N_2 phase leading to improved surface properties. The results show nitride formation behaviour to a depth of about 600 nm.

Figure 1 shows the depth profiles of the three treated alloy systems measured by a Hiden SIMS system shown in Figure 2. The distribution of MgN- ions suggests the formation of stable Mg-N bonds which is quite interesting because of the instability of the phase on air exposure due to the affinity to form oxides. The depth profile verifies this strong oxidation behaviour. Aluminium as alloying elements seems to be enriched at the interface and at the surface due to its oxide formation ability. Comparing the results especially those of SIMS the shape of depth profiles is typical for implantation methods. Stable coatings with enhanced properties have been formed.

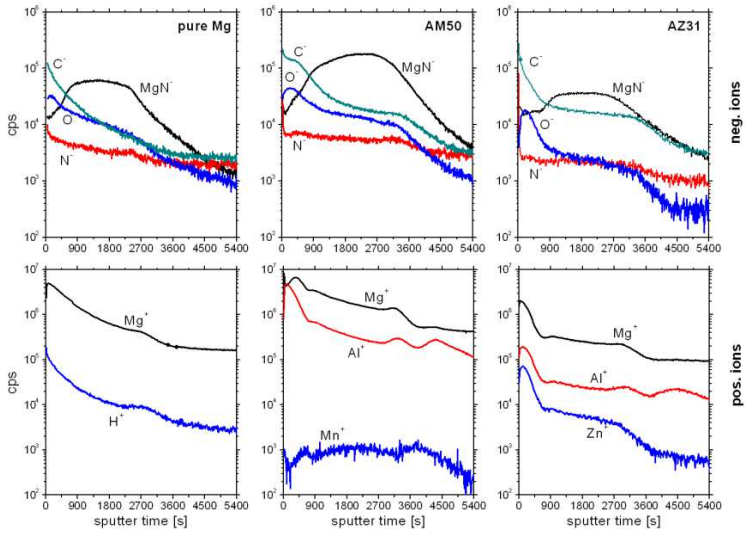


Figure 1 SIMS depth profiles according the reference paper

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The project gives an insight into the possibilities of using ion implantation to modify or tailor magnesium surfaces. The hardness has been increased to a factor of four; the corrosion resistance has been modified as well due to the Mg_3N_2 formation. Upcoming studies will give further information on challenges and the possibilities applying the method.

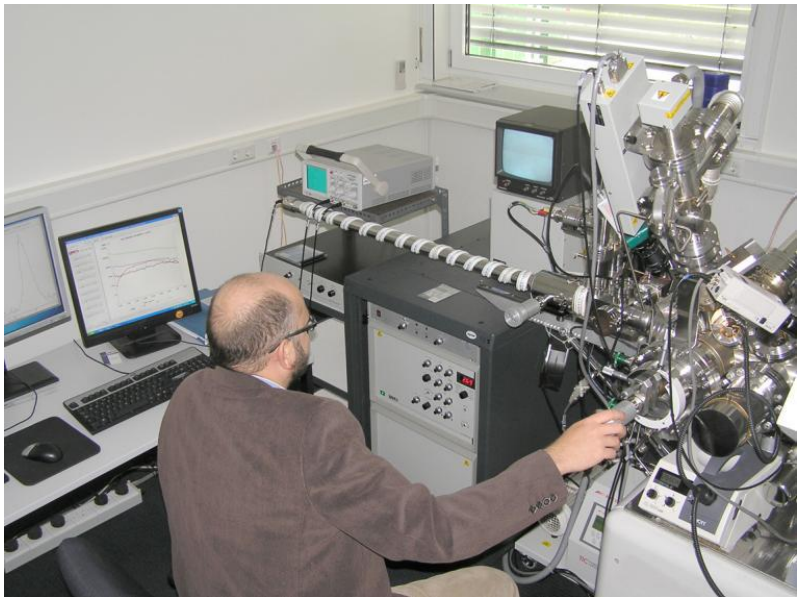


Figure 2 OEM fitment of MAXIM and IG20 SIMS system to a Kratos XPS surface analysis instrument, in Helmholtz-Zentrum Geesthacht, Zentrum für Material- und Küstenforschung GmbH

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Paper Reference:

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Additional activities:

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Analysis of PVD coatings:

Development of Mg based bulk metallic glass (glassy) coatings for example Mg-Gd-B with tailored properties in terms of corrosion and degradation. Hiden SIMS system has been applied to measure interface enrichments and elemental depth distributions like shown in Figure 3. This should help to optimize the deposition conditions according to stoichiometry, phase formation and thin-film growth using the HZG magnetron sputtering facility. In the future such coatings could be applied on implants, on castings or on other special devices.

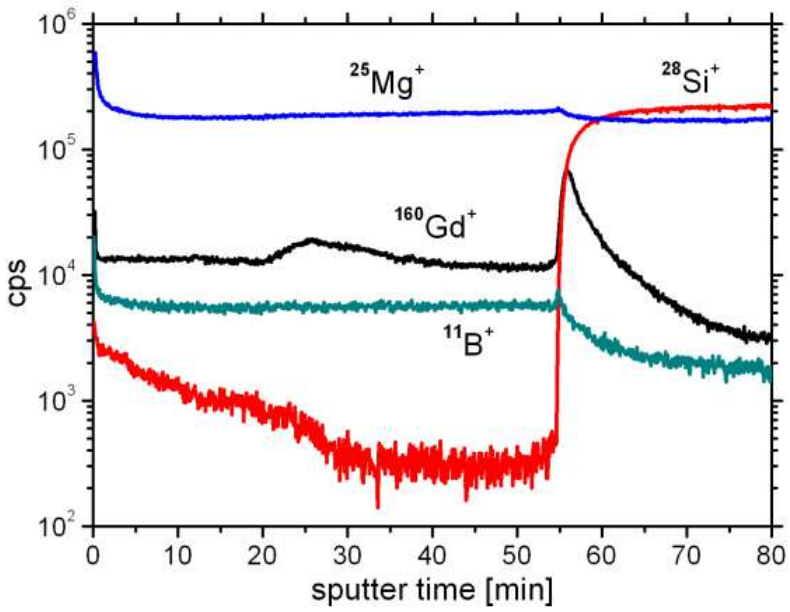


Figure 3 Depth profile of pos. ions of a ternary PVD coating on a silicon substrate

Reference:
Patent: EP2463399 (A1) / US2012148871 (A1)
- Magnesium components with improved corrosion resistance

Hiden Product:
MAXIM & IG20 SIMS Components

Follow the link to the product catalogue on our website for further information:
http://www.hidenanalytical.com/en/applications/SIMS-surface-analysis

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