Study of Carbon Fibre-Reinforced Magnesium Composites (Introduction to interfacial phenomenon)

Composite materials are known to combine interesting properties of different materials. This research concerns magnesium alloys reinforced by carbon fibres weaves. Such a material can theoretically exhibit a *yield strength/density* ratio around 500 compared to ~200 for Ti6Al4V and ~125 for Al2024-T6. This composite is thought to be especially promising for aeronautics.

The purposes of the research (financed by RW *Winnomat 2*) covers a wide spread of tasks and is developed together with Sirris Research Centre and UCL. One important task is related to the interface. The load on the composite is transferred to the reinforcement through this interface. The MMS Unit (ULg) is currently focused on the interactions between the metal matrix and the carbon fibres as the stress field in a composite material depends on these interactions. Moreover manufacturing has to be adapted in order to plan squeeze casting of liquid magnesium into carbon fibres weaves performs.

The strategy studied to enhance interaction between matrix and fibres consists in covering a thin layer of carbide former metal (Zr, Ti) by PVD as a primary treatment of carbon weaves. This intermediate product can then be heated up between 300-700°C in an argon atmosphere in order to form stable carbides. The wetability of treated weaves by liquid magnesium is potentially higher because carbides are not fully covalent (partially metallic) and so they can have more interface interaction with liquid metals. Further crystal lattice parameters of particular carbides can be close to the ones of metal crystal lattices and interface energy can consequently be reduced when they form carbide-metal bonds. Furthermore magnesium is known for its high oxygen attraction and is able to reduce a lot metallic oxides. It is a key fact because liquid magnesium easy wets its oxide in certain conditions.

The choice of suitable magnesium alloys has also to be discussed because they can contain interesting or poisonous chemical elements. Aluminium as alloying element is potentially undesired because of its pretty high reactivity with carbon and the bad wetability of formed carbide (Al_4C_3). In reverse alloying elements such as Zr or Ti would allow skipping pre-treatment and as a result reducing manufacturing costs. Because alloying elements are not pure their activity in magnesium has to be calculated with a thermodynamical simulation program (such as Thermocalc).

In conclusion CMg-MMC research is still in progress but some facts are already relevant. Firstly the reach of the theoretical performance of the composite depends on the ability of dealing with interaction between fibres and liquid metal. Secondly primary treatments of fibres could help to form bonds between matrix and fibres. Thirdly discussion and experimentation on alloying elements is necessary to deal with the fibres-matrix relations.

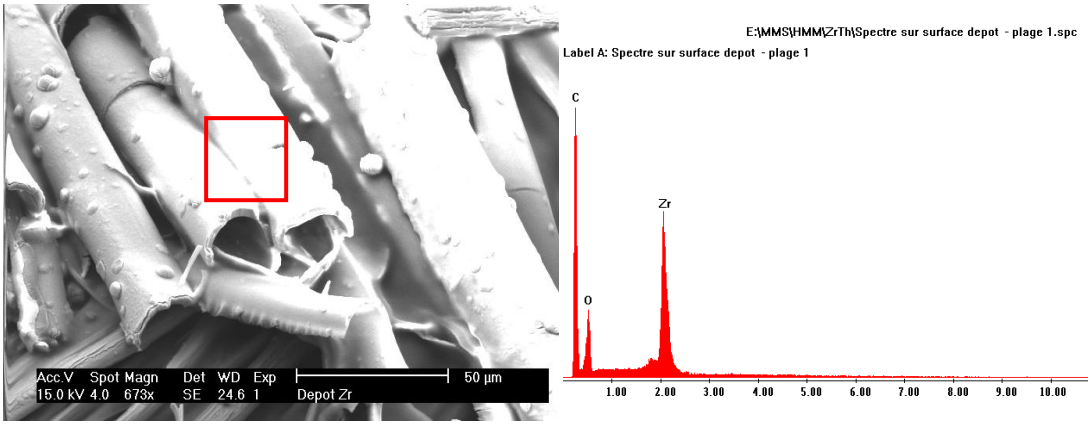

Figure: Heat treated Zr layer (got by PVD) on carbon fibres