PROTECTION AGAINST OXIDATION, BY CVD OR SPS COATINGS OF HAFNIUM CARBIDE AND SILICON CARBIDE, ON CARBON/CARBON COMPOSITES.

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The hafnium carbide compound is an ultra high refractory ceramic; as a result it could be of interest for the protection of carbon/carbon composites against oxidation at high temperatures. However HfC and most of metallic carbides present a non stoechiometric composition with carbon vacancies. As a consequence, the oxidation resistance is poor at low temperatures (500-1000°C). In order to overcome this main drawback the HfC can be associated with silicon carbide (SiC) presenting a better oxidation resistance at lower temperatures. Two coating routes have been studied; the first one is the Chemical Vapour Deposition which enables to obtain very thin coatings and the second one is the Spark Plasma Sintering technique which permits to get new microstructures of coatings.

On first hand, this study describes the CVD conditions for the deposition of HfC from the metallic hafnium pellets to get hafnium chlorides followed by the reduction of the chlorides by H_2 and the deposition of HfC with the methane as carbon precursor. This enables to get an alternated multilayer microstructure made of a first layer of SiC on top of which the first layer of HfC is deposited and so on to a ten alternated layer deposit [1].

In an other hand, SPS has permitted to sinter, on carbon substrate, ultra high refractory ceramic powders with a significant amount of SiC. The fluidized bed CVD is used to deposit a layer of SiC on top of HfC grains. The powder obtained has a core shell structure. This powder is then sintered on top of a C/C composite. The sintering conditions to obtain an uncraked coating will be presented as well as microstructures [2].

To achieve this study those two coatings have been tested up to 2000°C under air in an arc image furnace at a very high heating rate. As they are thicker the coatings obtained by SPS had been used to understand the oxidation mechanism involved during oxidation [3]. In terms of protection the CVD coatings enable to protect a C/C during 200 seconds at 2000°C and 370 seconds at 1900°C.

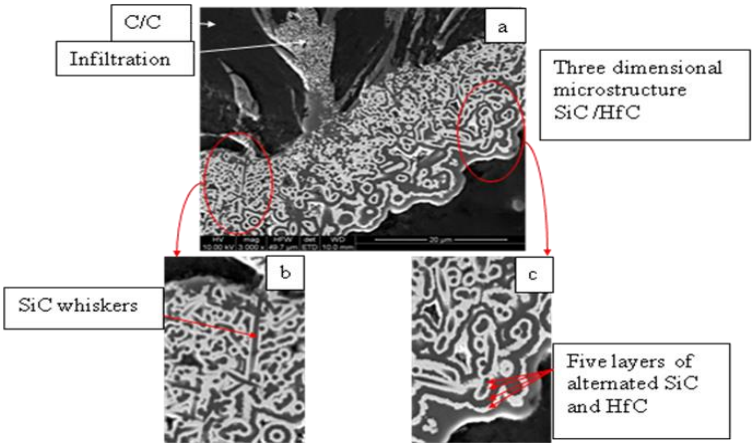

Figure 1 : SEM microstructure of a five alternated SiC/HfC coating made by CVD on a C/C composite

References

[1] A. Allemand, Y. Le Petitcorps, O. Szwedek Patent N°US2014287249 du 25/11/2011
[2] A. Allemand, Y. Le Petitcorps, O. Szwedek, L. Bianchi Patent N°US2014004271 du 25/10/2010
[3] C. Verdon, O. Szwedek, A. Allemand, S. Jacques, Y. Le Petitcorps, P. David « High temperature oxidation of two and three dimensional hafnium carbide and silicon carbide coatings » Journal of the European Ceramic Society 34, 2014, pp. 879-887