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"Arc and Plasma Spraying Today and in the 90th"

Prof. H.D. Steffens

Question (Dr. S. Amada) :

In these years, I am studying about ceramic coatings by plasma spraying, particularly its pore structures and its application to heat engines. Please allow me to ask my questions based on that point.

1. To improve plasma spraying technique it is required that the spraying process should be clarified based on the theoretical model, in particular, behavior of plasma jet, interactions between plasma jet and introduced particles, velocity and temperature of the particles residencing in jet, flattening process of the particles on the substrate and so on. What do you think of my comment?
2. In applying ceramic coatings to heat engines, such as TBC and insulating components in diesel engines, zirconia is the most attractive candidate because of low thermal conductivity. To realize, there exist several problems, for example, low adhesion strength, limited thickness of coating layer, instability of partial stabilized zirconia under hot flame. Is there any powerful approach to get over these barriers?
3. To drive researches and developments of plasma spraying technique further, we must have effective and simple evaluating methods of coating layer, which should be not only nation-wide but also world-wide acceptable methods. Do you have any idea about this point?
4. You presented recently developed hardwares of plasma spraying, for example, low pressure chamber, several stabilized torches, vacuum arc-spraying unit and so on. It may consider that plasma spraying can be also assisted by other heat source such as laser beam, so called a hybrid plasma spraying unit operated by more than two heat sources. I want to ask you about this approach?
5. They are trying to put an after treatment of plasma spray coating by HIP, laser glazing and so on to improve the physical and mechanical characteristics of the coatings. Can we expect these techniques?
6. The applications of plasma spraying technique is rapidly growing these days to various fields. However its market is still limited. The market extension can be prevented by several problems, typical one of which are cost performance and quality of coating layer. How do you think of plasma spraying technique in future?

Answer (Prof. H.D. Steffens) :

1. There is a large variety of possible ceramic coating

systems available, after years, however, till now Zirconia (partially stabilized) shows best overall properties. There are possible improvement in processing as well as possible selection in order to give better adhesion to the base material and avoid crack formation in or parallel to the surface.

I wonder whether there will be another ceramic system to replace the Zirconia coatings in the near future. I don't believe.

2. Problems in the application of sprayed coatings mainly arise due to inadequate coating properties and the lack of property control, so one of the most urgent development should be that of easy-applicable methods or non-destructive testing. These coatings would no longer be unpredictable in behaviour under enhanced severe conditions in respect to adhesion, crack formation, existence of pore clusters etc. Another step is the development of equipment and material based on scientific investigation of processing and governing process parameters; away from the try-and-error methods.

Composition and structure stability of ceramic coating are of governing influence on coating performance and highly dependent on kind of applied production process and process parameters. Then different processes provide quite different conditions, for instance on temperature and velocity. With the high speed processes (like D-gun) providing much lower particle temperatures than the usual plasma spray processes. In the future, the selection of process will no longer be subject of personal intuition but will have to carefully consider all these aspects in order to obtain optimum coating properties. I see two-way use of computers in thermal spraying, the first being a means of control of process parameters. There is an obvious necessity for that and it is being done already, as may be seen in JWRI-labs. The other use will be within an expert computer system where on the basis of data bank information and special software a proper design of coatings meeting service conditions best, may be carried out.

"Formation of Ceramics Coating by Laser Processes"

Dr. M. Wehr

Question (Dr. N. Yasunaga) :

Laser surface modification technologies have not been so much adopted yet in practical production in spite of their attractive features about which Dr. Wehr has presented. This means that these new technologies should be much more brought up to develop into future businesses. All