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Editorial

High Kinetic Process Developments in Thermal Spray Technology

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Invented about a century ago, the thermal spray technology today enjoys continuing growth and constantly ongoing development. Complexity and flexibility of thermal spraying as a surface coating technology is leading to continuously modified and improved processes, novel materials, and fields of application. Current developments in these areas have the potential to consolidate existing markets as well as to develop new markets in the future, for example, by developments in the field of novel nanostructured coating materials, improved processes for coating of internal diameters, or as alternative technology for replacement of other and potentially hazardous process routes such as electroplating. Due to its flexibility and universal applicability, thermal spraying is continuously facing more specific requirements and increasing demands for various applications. To meet these demands, and at the same time to be in accordance with constantly rising quality standards and to provide solutions for challenging coating applications, the spraying processes as well as the spray materials are subject to continually ongoing development.

The thermal spray technology showed a remarkable annual growth rate of 5-10% during the past decades, reflecting its potential for various fields of application. During the past 20 years the spray process technology developed a significant trend toward high-velocity spraying processes. The considerable increasing interest in high kinetic process technologies and their industrial usage are mainly due to the imminent advantageous properties of the process for the production of very dense, hard, wear- and corrosion-resistant metal-based coating systems. Furthermore, the high kinetic processes provide the possibility to significantly reduce oxidation and phase transformations throughout the coating process due to the comparably low particle temperatures that are achievable while still maintaining an efficient application of the spray coating.

For a further reduction of material reactions during high-velocity oxyfuel (HVOF) flame spraying by reduction of the temperature levels to which they are exposed, different approaches have been proposed and followed. Among others, they include modification of nozzle designs and usage of shrouds, an increase of combustion chamber pressure, as well as an optimized control of the flame temperature by purposeful selection of a suitable fuel type and method of supplying the fuel to the combustion process. The consequent continuation of this idea of a "cold" high-velocity spray process has finally led to the relatively new concept of cold gas dynamic spraying, which has strongly gained interest during the past 5-10 years and was introduced into industrial application in 2003 for the first time. Cold gas dynamic spraying offers a process alternative that is able to almost completely eliminate oxidation or phase transformation of the feedstock material. Research activities on the field of cold gas dynamic spraying are presently focusing on the modeling and simulation of the process and the material behavior during the high-speed impact of the relatively cold particles onto the substrate surface. Understanding of the splat behavior and correlated influences is assumed to be key knowledge to evaluate the processibility of any material system and develop new fields of application. Besides research on the fundamentals of the process, significant steps have also been undertaken with respect to equipment development. Today, modern gas heaters are available that allow an efficient and fast heating of the process gas in a wide temperature range and at high gas flow rates. Improved Laval nozzles guarantee an optimized acceleration of the powder particles and therefore an economic coating production with high deposition efficiencies. Last but not least, advanced robust high-pressure powder feeder systems supply a constant powder feed rate even with the fine powder grades usually applied for cold gas spraying.

After extensive studies on the processing of copper-base powders by cold gas spraying, investigating influences of particle size distribution, particle-substrate interactions, or effects of various posttreatment processes, current research work is looking at a broader variety of feedstock materials. Besides different aluminum alloys, titanium, nickel, zinc, as well as typically HVOF sprayed materials such as MCrAlY, 316L, or oxide-dispersion-strengthened (ODS) powders have also been evaluated for the production of high-performance coating systems by cold spraying. This impressive range of processible materials can provide optimized coating solutions for a variety of technical surfaces and even extend the fields of application for the thermal spray technology. Not only typical thermal spray applications such as corrosion and wear protection or repair and structural coatings are producible by cold spraying, but also coatings for demanding electric, electronic, or thermal applications as well as efficient deposition of soldering or brazing materials.

Considering the present situation and the remarkable technical developments in cold gas spraying in recent years, we can expect a seminal evolution of this process into various industrial applications in the upcoming years. The progress in the cold gas spray technology has the potential to consolidate and expand existing markets, and also to open up new markets in the future. In the next 15 years we will face an exciting period, dominated by further technical innovations and novel applications, but new and fast-growing economies such as China aspire to become a remarkably important future market for thermal spraying equipment, products, and services.

The ITSC 2005 has given impressive insight in the potential of thermal spraying and the multifaceted research activities and also particularly into developments in the field of cold gas spraying. Experts of thermal spraying and those who are interested in this technology have met in Basel, Switzerland to take part in the worldwide leading conference on that topic. A comprehensive technical program with 220 lectures, an extensive poster show, and an industrial exposition with more than 30 international companies provided

an optimum opportunity for sharing of latest information, profound discussions and excellent networking. This special issue of the Journal assembles a selection of papers presented at the conference. The selection was made among those that received a Best Paper Award and those that describe recent advances in the rapidly evolving cold spray technology.

We are looking forward to the next exciting events in the world of thermal spraying, the upcoming ITSC 2006 in Seattle and the ITSC 2007, when we will meet in Beijing, China.

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