

# Commentary

## History of Thermal Spraying: Seventies in Poland

Many recent studies on splats produced by impact of particles cite the fundamental paper of Madejski (Ref 1), and those of plasma particles diagnostics and modeling specialists who have a good memory still keep in mind the precursor study of Fiszdon and Lesinski (Ref 2). These studies, as many others, came from Polish research institutes in the 1970. During this decade I had finished my study, gotten my Ph.D. and started my work in thermal spraying area. I decided to write a few words about the people who worked then and there and contributed to the growth of thermal spray technology.

R&D activity on thermal spraying had taken place in that time mainly in Warsaw, Wroclaw, Czestochowa, and Cracow. A leading center of scientific activity on thermal spraying was then the Institute of Nuclear Research in Otwock near to Warsaw. The plasma section led by Professor Wojciech Brzozowski worked on:

- Plasma diagnostic by emission spectroscopy.
- Design of torches for plasma spraying technology. The torches were designed by Michal Mikos. The plasma spray installations called PN-110 and PN-200 were well disseminated in Poland, and some of them must have been used until today.
- Diagnostic of plasma jet particles two-phase stream. The velocity of particles was tested with a simple rotating mirror device and their temperature with a two-color pyrometer. The work in this area enabled Jacek Lesinski (today, a consultant in Limoges, France) to obtain his Ph.D. (Ref 3).
- Modeling of the plasma jet particles interaction and problems associated with formation of coating (splat formation, thermal fields at spraying, ...). The topic was worked out by, among others, Jerzy Fiszdon to obtain Ph.D. (Ref 4). The Ph.D. was made under supervision of Professor Jan Madejski, who was the first to analyze theoretically the problem of splat formation at spraying. Prof. Madejski (deceased in 2000) was an outstanding scientist; a member of Polish Academy of Science; a hero of World War II, and his professional achievements are shown on an Internet site (Ref 5).

The Institute of Nuclear Research edited a lot of reports (with a characteristic front page as shown in Fig. 1) that covered many areas of thermal spray technology. More applied research was conducted in Institute of Precision Mechanics under the leadership of Dr. Witold Milewski (who became Professor at the same institute). His precursor work on transformation in plasma spraying carbides was



Lech Pawlowski

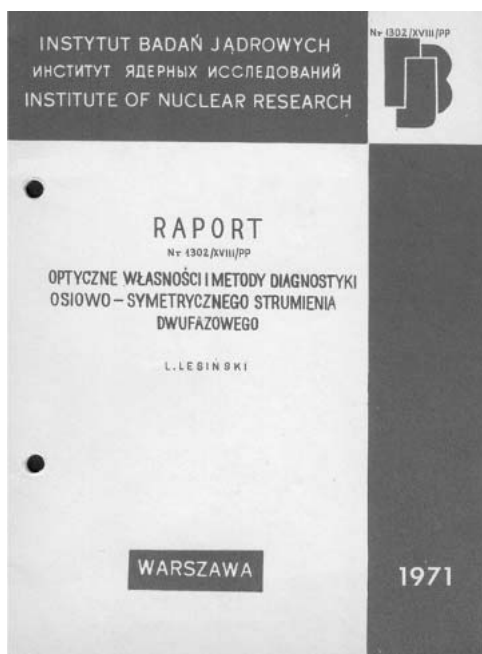


Fig. 1. Front page of one of the Institute of Nuclear Research reports

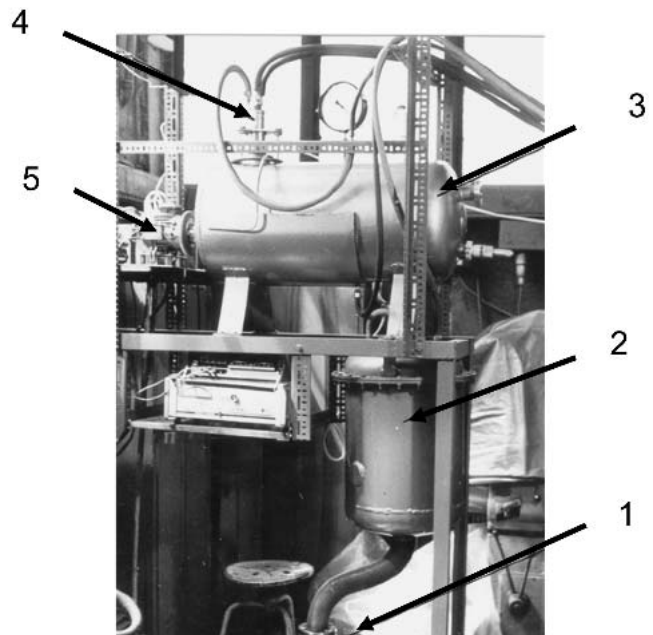


Fig. 2. Laboratory vacuum plasma spray installation (Ref 8). 1, to vacuum pump; 2, filter and gas cooler; 3, vacuum chamber (80 dm<sup>3</sup> of volume); 4, plasma torch; 5, mechanical system of moving substrates

frequently cited (Ref 6). The institute was active in dissemination of thermal spraying in Polish industry, educated many engineers—such as, for example, Andrew Sicinski (today a technical manager of Brenco in Melbourne, Australia)—and edited a professional journal “Powloki Ochronne,” that is, “Protective Coatings.”

Technical University of Wroclaw was then probably the second strongest research center in thermal spraying. Two outstanding professors led this activity: Albin Czernichowski at the Faculty of Chemistry (today a professor at University of Orléans in France) and Wladyslaw Kaczmar at the Faculty of Mechanics. Prof. Czernichowski carried out the research of plasma diagnostics and technology, including high frequency (HF), microwave plasma, and vacuum plasma spraying (Fig. 2) and educated many Ph.D. students, such as Jerzy Jurewicz, today a professor at Sherbrooke University in Canada and myself (Ref 7). Prof. Kaczmar developed technology of powders and wires for thermal spraying. His Ph.D. students include, among many others, Dr. Hubert Drzeniek (today manager of Amil in Würselen in Germany) and Dr. Zenon Babiak, a long-time researcher at University of Dortmund (currently retired).

Technical University of Czestochowa and Institute of Metal Cutting in Cracow led the research close to industrial applications. Dr. Morel from Czestochowa and Dr. Basinska-Pampuch from Cracow contributed to development of many industrial technologies related to thermal spraying and organized symposia on this area (e.g., in Kokotek near to Czestochowa).

What remains from these years? A major asset is a lot of educated engineers, researchers, and professors, many of them contributing to thermal spray technology outside of Poland. The country then had rather limited contact with developed technology. To the contrary, Polish technology of today is well established in European industry, and young engineers will surely accomplish new achievements worth reading about in the future.

## References

1. J. Madejski, Solidification of Droplets on a Cold Surface, *Int. J. Heat Mass Transfer*, Vol 19, 1976, p 1009-1013
2. J. Fiszdon and J. Lesinski, Accélération et fusion de grains dans un jet du plasma d'argon-hydrogène, *International Round Table on Study and Application of Transport Phenomena in Thermal Plasma* (Odeillo, France), Sept 12-16, 1976, paper IV.1
3. J. Lesinski, “Investigations on Heat and Momentum Transfer between Solid Particles and Argon-Hydrogen Plasma,” Ph.D., Institute of Nuclear Research, Warsaw, 1975 (in Polish)
4. J. Fiszdon, “Method of Analysis of Spherical Solid Particles in Plasma Jet,” Ph.D., Institute of Nuclear Research, Warsaw, 1975 (in Polish)
5. [http://www.imp.gda.pl/inst\\_zew/ppw/Madejski.htm](http://www.imp.gda.pl/inst_zew/ppw/Madejski.htm)
6. W. Milewski, Some Phenomena Occurring During Plasma Spraying WC + Co Compositions, *Seventh ITSC* (London, U.K.), Sept 1-14, 1973, p 24-33
7. <http://perso.wanadoo.fr/albin.czernichowski/>
8. L. Pawlowski, “Analysis of the Application Possibility of Plasma Spraying Process in Microelectronics Basing onto Research of the VPS Copper and Tantalum Coatings,” Ph.D., Technical University of Wroclaw, 1978

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