Editorial: Advanced (non-traditional) machining

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Advanced engineering materials are being developed to meet the demands of present day industries involved in making space aircraft, aeroplanes, nuclear power plants, automobiles, super computers, MEMS and other similar products. These materials have super qualities like very high strength and hardness, and high corrosion and heat resistance. To size and shape these materials with a high surface integrity and super finish (nano-meter range) is a real challenge to the manufacturing engineers. Traditional machining processes are incapable of meeting the demands of machining and finishing the products made of these materials, economically and efficiently. The only recourse left is to use advanced (non-traditional) machining and finishing processes.

The advanced machining processes (AMPs) include those processes developed relatively recently, say, after the 1950s, for example, electrochemical machining, photochemical machining, abrasive flow machining, magnetic abrasive finishing, magnetorheological abrasive finishing, electric discharge machining, electron beam machining, laser beam machining and many more. Most of these processes are being practiced in advanced industries but some of the AMPs are still within the boundaries of research and development houses.

Nano-technology is a highly interdisciplinary area that demands collaboration between multiple fields of science and engineering including biology, physics, chemistry, electronics, manufacturing engineering and so on. This technology deals with sub-micron dimensions. To shape, size and finish the components for various applications, one has to manipulate atoms and molecules. Even if one can develop the techniques to manipulate at this level, one should be able to directly or indirectly see (or measure), what they are working with. With this intention in mind, IBM researchers developed the Scanning Tunnelling Microscope and Atomic Force Microscope. This equipment is used to probe and image individual atoms. Now it is very clear that nanotechnology will have far reaching effects in the manufacturing, computing, biotechnology industries, etc. Some of the papers in this special issue deal with such aspects related to nano-finishing.

This special issue consists of 19 interesting research papers from different parts of the world. The majority of these papers are experimental in nature but some of them can be put in a separate category named 'Computational ADvanced MAchining (CADMA)'. In one of the CADMA category papers (Yadav et al.) deal with the application of the finite element method for temperature evaluation and thermal stresses generated during thermoelectric-type advanced machining processes, namely, electrodischarge diamond grinding. The knowledge of the residual thermal stresses produced during machining is important from the component's suitability point of view. There is another paper by Mulik and Yadava dealing with this problem in electrochemical spark machining, another hybrid process useful for machining of electrically non-conducting materials like ceramics. There are three papers which deal with the modelling of AMPs. Ramesh Babu and co-workers developed a theoretical model for predicting the depth of penetration in Abrasive Water Jet Cutting while Zhang and others developed a model to predict the surface roughness achievable during EDM in a gas environment and assisted by ultrasonic vibration. One of the papers (Joshi et al.) discusses modelling of micro-EDM.

Micromachining is another area in which intensive research work is going on. Some of the articles in this special issue address the problem of μ-machining. High quality experimental research work is always appreciated in the user industries. The majority of the AMPs are capable of μ-machining of metals and non-metals by proper selection of machining parameters. Muthukumaran and Co-workers report about the gas phase μ-machining suitable for fabrication of silicon based μ-systems. Three papers deal with experimental findings in ultrasonic machining. One of these papers (Li et al.) suggests an innovative coolant system for rotary USM while the other one (Ramulu) deals with the characterisation of the machined surface. Jiao and others studied the performance of rotary USM of ceramics. The objective of developing any hybrid process is to have a new process whose performance is better than its constituent processes. Zhang and co-workers report about the numerical control of the ultrasonic assisted electric discharge machine tool. It enhances the process performance by hybridisation. One of the most popular AMPs is the EDM process which occupies the space of three papers in this issue. One paper (Brahmankar and Ramakrishnan) deals with the characterisation of the electric discharge machined metal matrix composites while another one (Kansal and others) discusses the EDM using powder mixed dielectric with the application of the Taguchi method. Sarkar and co-workers report the application of wire-EDM for machining of gamma-titanium aluminide alloy. However, this special issue also has one paper on each of the processes, namely, abrasive flow machining (Amreesh et al.), electrochemical boring (Hocheng et al.), electrochemical finishing (Zhou et al.), laser beam machining (Kaur et al.), and pulsed water jet cutting (Jackson). Abrasive Flow Machining (AFM) is the process which has been used to achieve sub-micron (as good as 50 nm) surface roughness even on complex-shaped workpieces. This paper (Amreesh et al.) deals with the evaluation of viscosity of the medium used in AFM. One of the papers (Sharma and Kumar) discusses the use of water energy for coal cutting for which purpose this process was initially developed in Japan. I hope this special issue will work as a reference volume consisting of high quality research papers especially for those researchers who are working in the area of AMPs.

The quality of any journal or special issue of a journal cannot be maintained without the peer reviewers. All the reviewers of this special issue have been very cooperative in reviewing the papers and returning them in time, which helped in completing the review process as per the schedule. I would like to thank all of them.