NONCONVENTIONAL TECHNOLOGIES – ESSENTIAL WAYS OF MACHINING OF MINIATURE OBJECTS (MICRO - AND NANO - DIMENSIONALS)

The end of last millennium and the start of the third one are characterised, technically speaking, by an extraordinary extension of technological space, especially towards miniature dimensions known as micro-technologies or, for the moment, towards the bottom limits of nano-technologies.

Speedy technicality of nano-outer space, especially of the micro-dimensional one, is not anymore a scientific world curiosity as it was seen at the beginnings. It became a more significant necessity of life, including manifestations in the most important areas of human activity. This necessity is determined especially on one side, by the information society where the informative flux is rapidly evolving directly accorded with the real-time processing of these information and on the other side, by the more stringent necessity of society to dispose of all new and with special properties materials, capable to satisfy stringent requests imposed by new exploitation conditions.

The technological space extension phenomena towards micro and nano-dimensions is a specific phenomena of the last human developing period, last century being characterised by 30-years periods when machining dimensions and current technical machining precision increased 10 times [A]. With this rhythm, the drastic limitation of proven scientific possibilities was reached today due to technical impossibilities to apply useful scientific breakthroughs. Only one eloquent example can be given in this sense, namely the one of electronic computers' memories. The scientific research in this field led to the conclusion that for memorise a BIT is theoretically enough a single molecule [B]. Through the possible accomplishments of micro and nano-technology, it can be created memories capable to enormously increase the capacity of memorise and so, proportionally increase the working capacity of electronic computers.

A precise delimitation in macro-technology, micro-technology and nano-technology is not finalised up to present, but there are more and more pragmatic opinions, which define the dimensional fields of machining technologies. According to these opinions, the three dimensional fields can be:

- Nano-technologies are technologies which have as objective to achieve pieces, subassemblies and assemblies with dimensions lower than 100 nm;

- Micro-technologies are technologies which have as objective to achieve pieces, subassemblies and assemblies with dimensions between 100 nm and 0.1mm;

- Macro-technologies are technologies which have as objective to achieve pieces, subassemblies and assemblies with dimensions greater than 0.1 mm.

Practically, it can be said that micro - and nano-technologies are derived from macro-technology through miniaturisation and through adapting structures, components and functions to the more stringent necessities to frame them in small and very small spaces, keeping integer their properties, characteristics and functionality.

Technologically speaking, between nano-technology and micro-technology an essential difference can be observed, valid for actual level of technical-scientific development.

Micro-technologies are accepted as similar technologies with macro-technologies, mentioning that they have to be adapted to miniature dimensional conditions, which is leading to acceptance only of those technological processes of machining where the tool requirements are between the capable limits to assure their dimensional and form stability. According to these acceptances, micro-technologies can be framed in the area of destructive processes because to achieve final shape, material is needed to be removed.

Unlike the micro-technologies, miniature technologies to nano-metric level do not have, at the technological level reached today, any resemblance with the macro-technologies. Nano-technologies, operating to atomic or molecular level, are characterised by composing of nano-metric units or by implementation in the superficial layers of macro-dimensional structures of atomic or molecular units. So, nano-technologies have to be framed in the area of constructive processes specific to technological method of machining through aggregation, where the final form is reached through aggregation of some structures, even if can be noticed some exceptions of applicability like, for example, lithographic processes to achieve structures from processors' components [C].

It must be mentioned the fact that partial appearance of micro-technologies and complete appearance of nano-technologies is representing the end of a long technical evolution. If up to now tool effect was a touchable, visible or noticeable one in any way, the new miniature technologies are not accessible to our senses, that is why necessity of an "intelligible translation" of these images by electronic computers is needed. This fact – visualisation with instruments of micro- or nano-technologies, is leading to simulation facility of nano or macro-structures, what actually means the possibility to minimise the negative effect of a new technology or even to completely eliminate these effects. Only these findings is leading to the idea that new miniature technologies are situated at the border of specialised fields which interact, become inter-dependant and are conditioned one by another. Due to these interrelations, the miniature technologies can be called convergent technologies.

Starting from these delimitations between micro-technology and nano-technology, it can be accepted the idea that miniature technologies applied at least up to the present, are very different.

The first group, the one of micro-technologies, is generally appealing to known technologies already applied, especially in macro-technology field, adapted to the new miniature conditions, related to these, new technological possibilities emerging exclusively dedicated to micro-technologies. In principle, the technologies applied to micro-technologies are not making any difference between conventional and nonconventional ones, all of them being applicable through specific adjustments. But exactly these adjustments are leading to "elimination" of some technological processes from area of the ones applied to micro-technologies. Main adjustment is in the dimensional field, much sub-millimetre one, which is leading to a reduced rigidity of tools and so, to impossibility to use it for conventional dimensional machining processes. Even though, for some applications, especially the one pretending greater dimensions, it can be used machining processes as cutting and plastic deformation.

In exchange, nonconventional technologies, where stiffness of necessary object to spatially localise the eroding agent - accepted tool for these machining processes can be very little or even non existent, are a great importance for micro-technologies. Thus, machining processes with jets, where jet diameter can be reduced to micro-technologies specific values, are representing basic dimensional machining processes for micro-technologies' applicability. Photon (laser) beam machining and the ones with corpuscular jets (electronic beam and ionic beam) are already dimensional machining processes specific to micro-technologies. They are applicable not only to dimensional machining, but are also useful for structural or chemical modification processes, for determination of some dimensions or properties, etc.

Electrical discharge machining is also a largely applicable process for micro-technologies from superior dimensions field (tenths and hundredths of millimetre). The existence of extremely low stresses exerted by eroding process on tool-electrode is leading to easily utilisation possibility of these kinds of reduced dimensions elements (tenths and hundredths of millimetre). Their low stiffness, with negative effects upon machining only in additional areas of working gap, can be increased through simple mechanical constructions (guidings), which do not have effect on machining process, but which assure necessary spatial position for tool-electrode with low stiffness.

A special place for micro-dimensional machining is occupied by chemical erosion. As this dimensional machining process is one of few machining processes with material removal which does not develop forces, so there are no stresses of stiff objects during machining process, the machined objects and participating stiff objects to material removal process can be of extremely low stiffness, in the very end even not to be stiff at all. This advantage makes chemical erosion process to be one of the processes that presently are on of the first places in macro-dimensional machining processes and also to posses an important place in the nano-machining field. It has to be noticed the fact that combined processes which are based on chemical actions – electrochemical erosion and complex electrical erosion – have an extremely high range of applicability in this micro-dimensional field.

Nano-dimensional field through its specific, characterised by dimensions placed to an extreme dimensional limit, cannot appeal to presently understood machining processes. Talking about outer space units where at atomic or molecular dimensional level, their stiffness is not manifesting, which leads to impossibility to apply even adapted presently known conventional or nonconventional machining processes (with partial exception of chemical erosion). For machining in this dimensional field are necessary chemistry, biology and physics' specific techniques and technologies, to achieve units of pointed spot, linear or surface structures and to implement nano-metric structures into superficial layers of some macro-bodies in order to modify their superficial properties.

From presented ones in can be concluded that nonconventional dimensional machining technologies are occupying an important place in the area of objects machining technologies, characterised by micro-dimensions and is the only destructive possibility of action upon objects to nano-dimensional level. At their application, these technologies are totally respecting technological principles, physical mechanisms and principled structure of necessary technological systems, but also pretend some rules and particularities to become efficient in micro-dimensional field.

This finding is leading to necessity of focusing scientific research from nonconventional machining field also to this domain, especially that applicability of micro-products is rapidly enlarging.

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