

DocMASE Project Proposal DAAD-2018-1

Project Title	Coatings for tool cathodes used in electrochemical precision machining of materials based on titanium
Main University and Advisor	Saarland University, Prof. Dr. Dirk Bähre (Chair for Production Engineering)
Associated Partner(s) (if applicable)	
Project Description (with image , if applicable)	<p>Electrochemical machining (ECM) is suitable for the machining of metallic materials, even if particular properties like hardness or toughness complicate or prevent a modeling through mechanical manufacturing processes. Hence, in many cases, ECM is a key technology enabling a broad application of new materials, such as materials based on titanium which are used for stressed components in lightweight automotive and aeronautical construction. New process variants are based on the fact that the electrical current and movement of the workpiece are applied in a pulsating manner. This leads to a much higher manufacturing precision. Therefore, ECM has the potential to create complex workpiece geometries that are efficient, highly reproducible and very accurate within the submicron range, provided that all process influences are under control.</p> <p>The shape and strength of the electric field between the cathodically polarized tool and the anodically polarized workpiece heavily influence the material removal process and the result of ECM. In order to specifically direct the material removal, parts of the tool have to be isolated. The finer and more accurate the isolation, the more precise the creation of defined surfaces and geometrical elements with ECM. Thus, the coating for ECM tools needs to meet various requirements in regard to electrical, mechanical, thermal, chemical, geometrical and structural properties. Coatings that are sufficiently thin, electrically isolated and stable under process conditions have hardly been defined and analyzed according to scientific criteria up to now. With regard to the practical application, the potential of ECM regarding precision machining of high-quality technical workpieces has not been exhausted yet.</p> <p>Basing on preliminary works on pulsed electrochemical processes, while focusing on precision shaping and the machining of materials based on titanium as well as taking into account the requirements of ECM processes, layer systems will have to be defined. Those will also have to be able to be applied for fine structures and geometries. Furthermore, the behavior of the coat of the cathode will be investigated experimentally and optimized systematically. Through the use of analysis methods referring to the material and the manufacturing process, the reciprocal effects between the electrolyte, coating and cathode substrate material under the requirements of the ECM process as well as the changes and mechanisms of action will be described, too. The optimization will then be realized according to the criteria of durability and effectiveness while also considering their consequences on the machining accuracy during pulsed ECM.</p>
Previous Publications	
Requirements of the candidates / Requirements during the doctoral programme (courses, seminars, etc.)	<p>Very good English command. Bachelor in Materials Science, Mechanical Engineering, Chemistry, Physics or related disciplines. Master in Materials Science or related disciplines. Knowledge of German will be appreciated but not compulsory.</p> <p>The general requirements for the DocMASE program regarding courses, seminars, summer schools, etc. must be fulfilled. Particularly, 30 ECTS of lectures have to be validated at the end of the PhD and you are expected to publish the results of your studies in international peer-reviewed journals.</p>