# Analysis of the Electrochemical Removal of Aluminum Matrix Composites Using Multiphysics Simulation

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## Abstract

Composite materials are combinations of two or more chemically and physically different materials. Because of these differences many challenges in machining such materials are existing [1, 2, 3]. In the Collaborative Research Centre SFB 692 at the Technische Universität Chemnitz several academic institutions work on aluminum matrix composites (AMCs). These materials consist of an aluminum matrix, which is reinforced by particles, e.g. SiC or Al2O3 with dimensions less or equal 1 µm. In the SFB 692 such materials are studied from the development process, on different ways of machining, to the search for potential application. One main task is the finishing machining of AMCs by electrochemical machining (ECM).

The manufacturing technology ECM, which is based on anodic dissolution, has a slight influence on the work piece material structure and is independent of material strength and hardness. The goals of the research are depending on the application whether to resolve the matrix specifically to uncover the particles, to resolve the whole composite or to anodize locally the aluminum [4]. For the process design, the electrochemical characteristics of the AMCs have to be analyzed. For that reason an analyzing device for an existing prototype system, which is shown in figure 1, is developed. The system consists of an 3-axis machine table with travel lengths of 150x150x50 mm³, which is self-built. With the analyzing device (figure 2) it is possible to characterize the influence of different parameters such as electrolyte or applied voltage on the removal process under application-oriented conditions. The electrode is fixed to the process chamber and moves toward the workpiece. The electrolyte flushes transversely through the working gap. The working gap is adjustable up to 200 µm.

For the design of the device, simulation with COMSOL Multiphysics® is performed. Within this simulation especially the current density will be analyzed and the influence of the particles on the electrochemical removal process will be studied.

As a result of this study information about the removal characteristic are obtained. Also information inter alia about the sizing of the device, the working gap between the tool and workpiece and the electrolyte flow are obtained from the simulation.

## Reference

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[2] F. Müller, J. Monaghan, "Non-conventional machining of particle reinforced metal matrix composite," Int. J. Mach. Tools Manuf., vol. 40, no. 9, pp. 1351–1366, DOI: 10.1016/S0890-6955(99)00121-2, Jul. 2000.
[3] F. Müller, J. Monaghan, "Non-conventional machining of particle reinforced metal matrix composites," J. Mater. Process. Technol., vol. 118, no. 1–3, pp. 278–285, DOI: 10.1016/S0924-0136(01)00941-4, Dec. 2001.
[4] K. Hockauf, L. Köhler, M. Händel, T. Halle, D. Nickel, G. Alisch, T. Lampke, "The effect of anodic oxide coating on the fatigue behaviour of AA6082 with an ultrafine-grained microstructure," Materwiss. Werksttech., vol. 42, no. 7, pp. 624–631, DOI: 10.1002/mawe.201100837, Jul. 2011.

## Figures used in the abstract

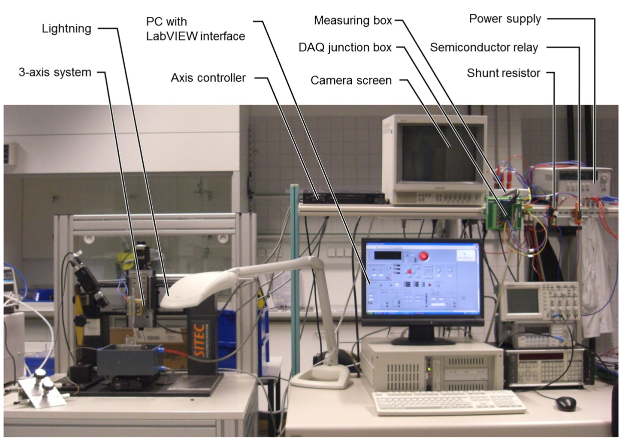


**Figure 1**: Picture of the prototype system

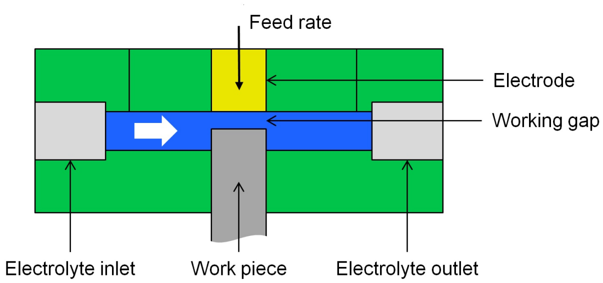


**Figure 2**: Sketch of the analysing device