Production and Properties of DiaChem® Electrodes for Industrial Applications

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In the last years doped diamond thin film electrodes have been studied intensively with regard to industrial applications. The most important properties of diamond electrodes for electrochemical applications are the unique chemical inertness, the widest known electrochemical window before water decomposition takes place and the use as anode as well as cathode. Due to these outstanding properties and the high electrochemical efficiency there is a strongly increasing demand for diamond electrodes in the field of water treatment, electrochemical synthesis and electroplating.

In a co-operation between Fraunhofer IST, Germany, and CSEM, Switzerland, we have produced DiaChem® electrodes[1] by large-area hot-filament CVD (HFCVD) on different industrial electrode materials, like niobium, tantalum, titanium and graphite as well as silicon or silicon carbide on areas up to 50cm x 100cm. For industrial electrodes a wide range of different geometries is necessary. DiaChem® electrodes are available as disks, plates, cylinders, tubes or grids (Figure 1and 2). The homogeneous coating and diamond film morphology is demonstrated in Figure 2. Typical film thickness is between 0.5µm and 5.0µm. For low resistivities as 5 to 100mΩcm doping levels from 50ppm up to some thousand ppm boron have been realized using B_2H_6 and TMB. Beside of the standard boron doped DiaChem® electrode we developed also a process for co-doping of boron and nitrogen. This process yields diamond electrodes with low resistivity and increased overpotential for hydrogen evolution (Figure 3).

The DiaChem® electrodes have been characterized with regard to their material and electrochemical properties. We will present and discuss our investigations concerning electrode performance, electrode stability and lifetime.

References

1. M. Fryda, A. Dietz, D. Herrmann, A. Hampel, L. Schäfer, C.-P. Klages, A. Perret, W. Haenni, C. Comninellis, D. Gandini, Electrochemical Proceedings Volume 99-32, 2000, 473

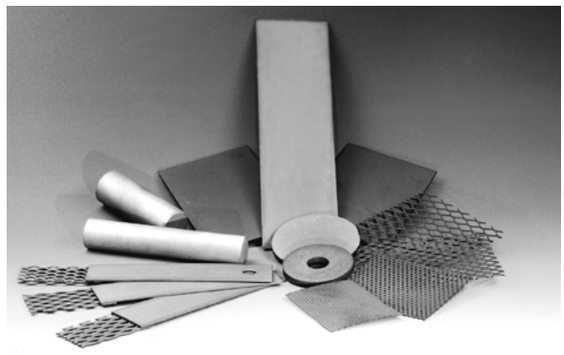

Figure 1: DiaChem® electrodes with different substrate materials and geometries

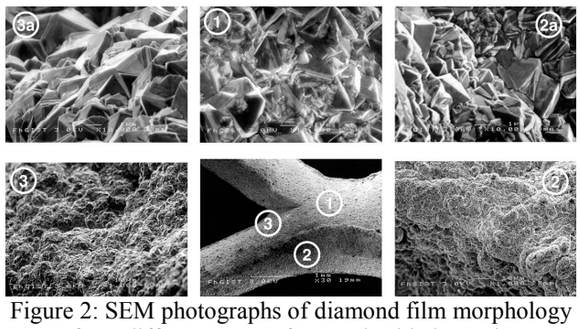

Figure 2: SEM photographs of diamond film morphology from different areas of a metal grid electrode

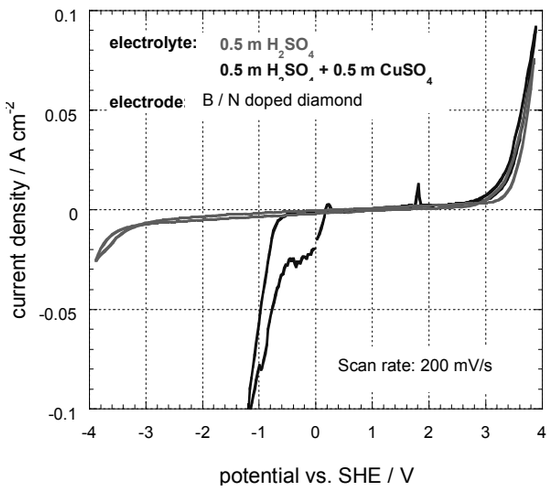

Figure 3: Grey diagram line - CV of B/N co-doped diamond electrode in 0.5m sulphiric acid as electrolyte. Dark diagram line - CV of B/N co-doped diamond electrode in 0.5m sulfuric acid and 0.5m copper sulfate as electrolyte