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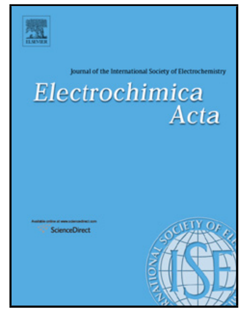

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Nanometer-scale accuracy electrochemical micromachining with adjustable inductance

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Electrochemical micromachining technique using ultra short pulses can increase machining resolution. However, the pulse duration is the only effective control parameter of the machining resolution. Here, we propose a controlled electrochemical micromachining technique. We added an adjustable inductance element in the equivalent circuit of the electrochemical micromachining to form a coupled fluid-electric circuit. The machining resolution depends on both local separation between the electrodes and the adjustable inductance. So, the adjustable inductance can be taken as another effective control parameter of the machining resolution. As the inductance increases, the large polarization voltage can be more easily confined to the electrode regions in very close proximity. This technique was used for machining some micro structures, and a nanometer scale machining resolution was achieved easily when an ordinary pulse source is used.

Micro machining technologies play an important role in the miniaturization of the micro and nano system[1-3]. Electrochemical micromachining has a good development potential in the micromachining fields of materials because the material transfers on ion scales in the electrochemical micromachining and the metal ion scales are smaller than 10% of nanometer. Electrochemical micromachining technique using ultra short pulses can increase machining resolution significantly[4]. With this technique, the machining of new materials and structures were performed[5-9], and the meso/micro/nano-ultra-precision machining was achieved[10-11]. To increase micromachining precision of this technique, the improved size and shape of the electrode[12-13], the reduced duration of the ultrashort pulse[14], and the optimum duty cycle of the pulse[15] were investigated. The simulation approaches and computational models of the pulse electrochemical machining were proposed[16-23].

However, the pulse duration is nearly the only control parameter of the machining resolution since the ultra-short pulse electrochemical micromachining technique was proposed in 2000. Shorting the pulse duration can linearly increase the machining precision. To obtain nanometer scale machining precision, ps scales of the pulse duration must be used[24]. It needs expensive ultra-short pulse voltage source. Therefore, a novel electrochemical micromachining technique with more control parameters should be proposed.

Here, we propose controlled electrochemical micromachining technique in which the machining resolution of the materials does not only depend on current pulse duration, it also depends on other control parameters. We added an adjustable inductance element in the equivalent circuit of the electrochemical micromachining to form a coupled fluid-electric circuit.

Compared with the ultra-short voltage pulse technique, the method has mainly two advantages:

(1) It does not need special pulse sources. A usual signal generator is enough for the technique.

(2) The machining resolution of the materials does not only depend on current pulse width. It also depends on the circuit inductance. The circuit inductance is a more convenient control