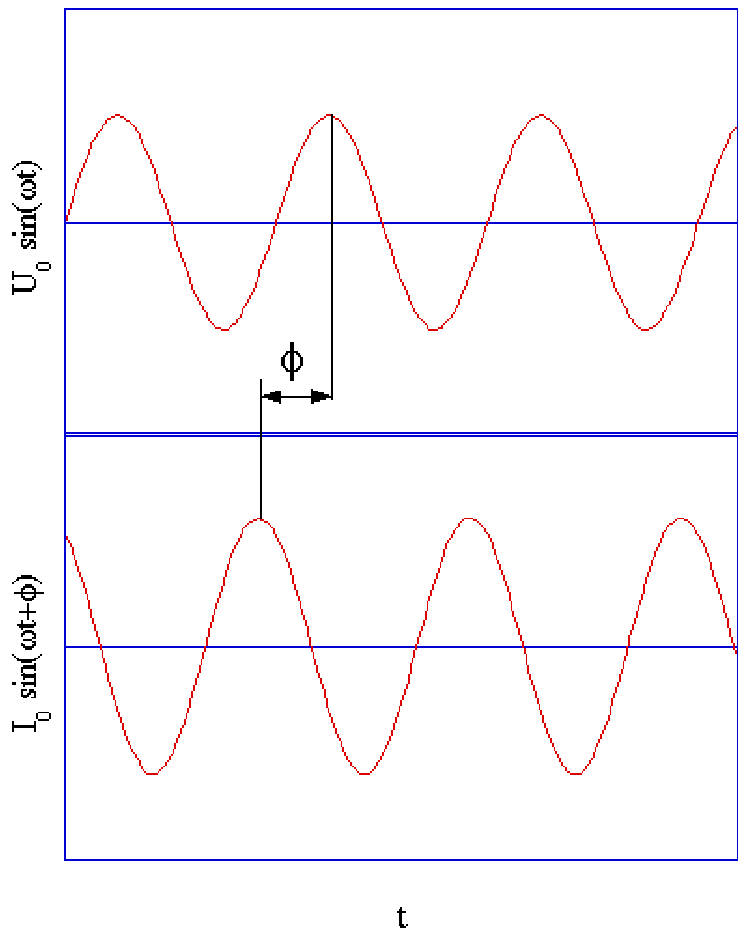

Phase shift between voltage and current

Fig. 1. In an "ac" excited system, voltage and current are generally phase shifted.

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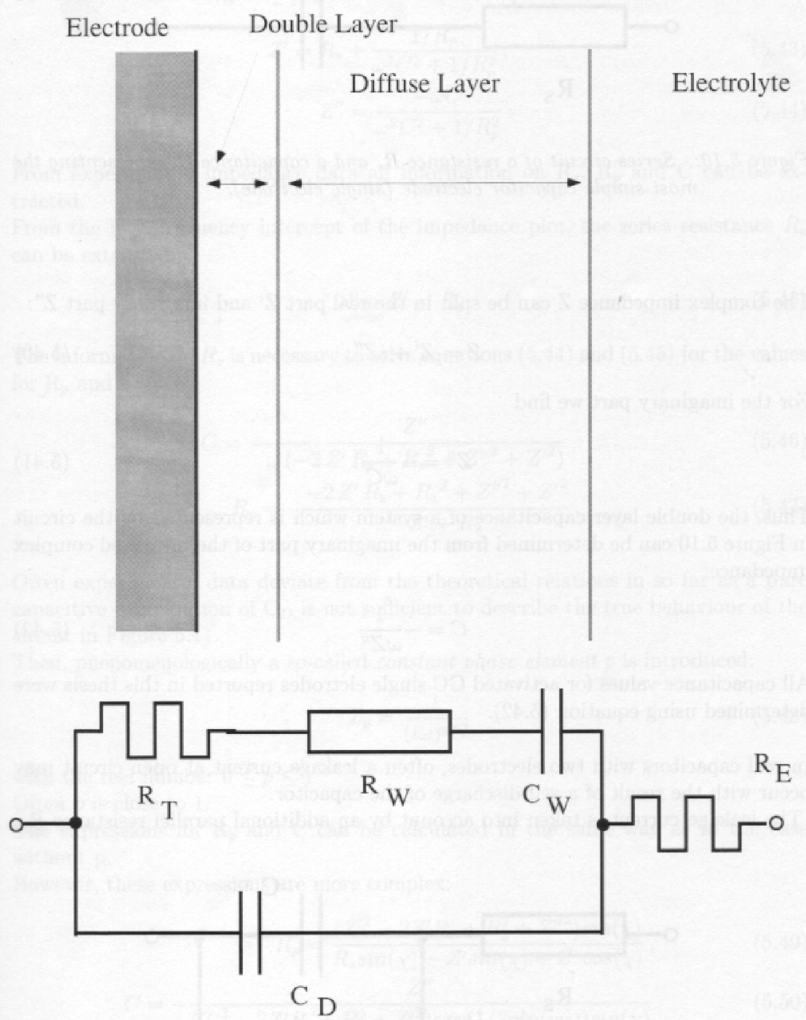

Figure 5.9: Schematic of the electrochemical interface and its corresponding electric circuit.

Fig. 2. Schematic of electrochemical interface and corresponding electric circuit.

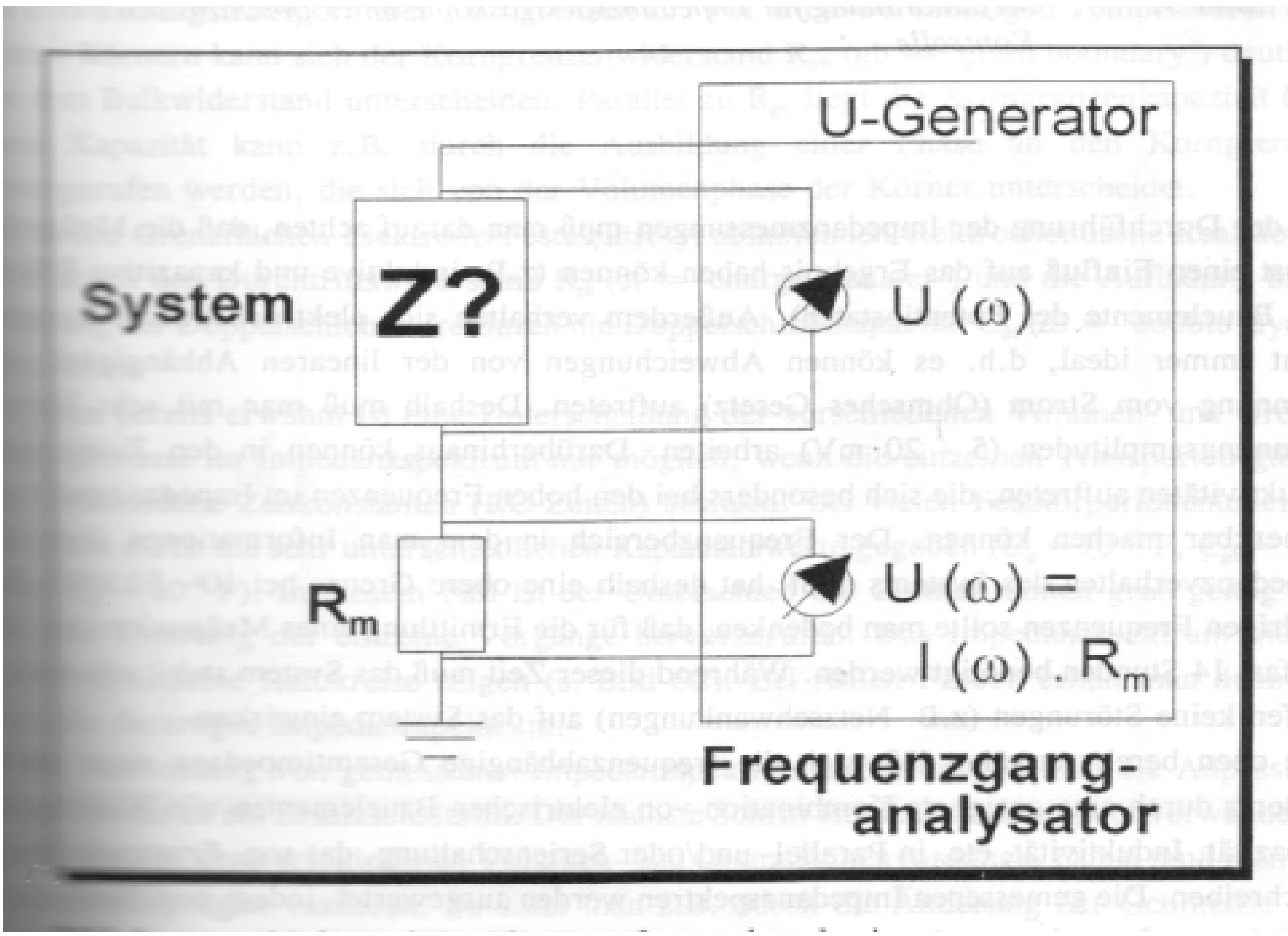

Fig. 3. Operation principle of impedance measurement.

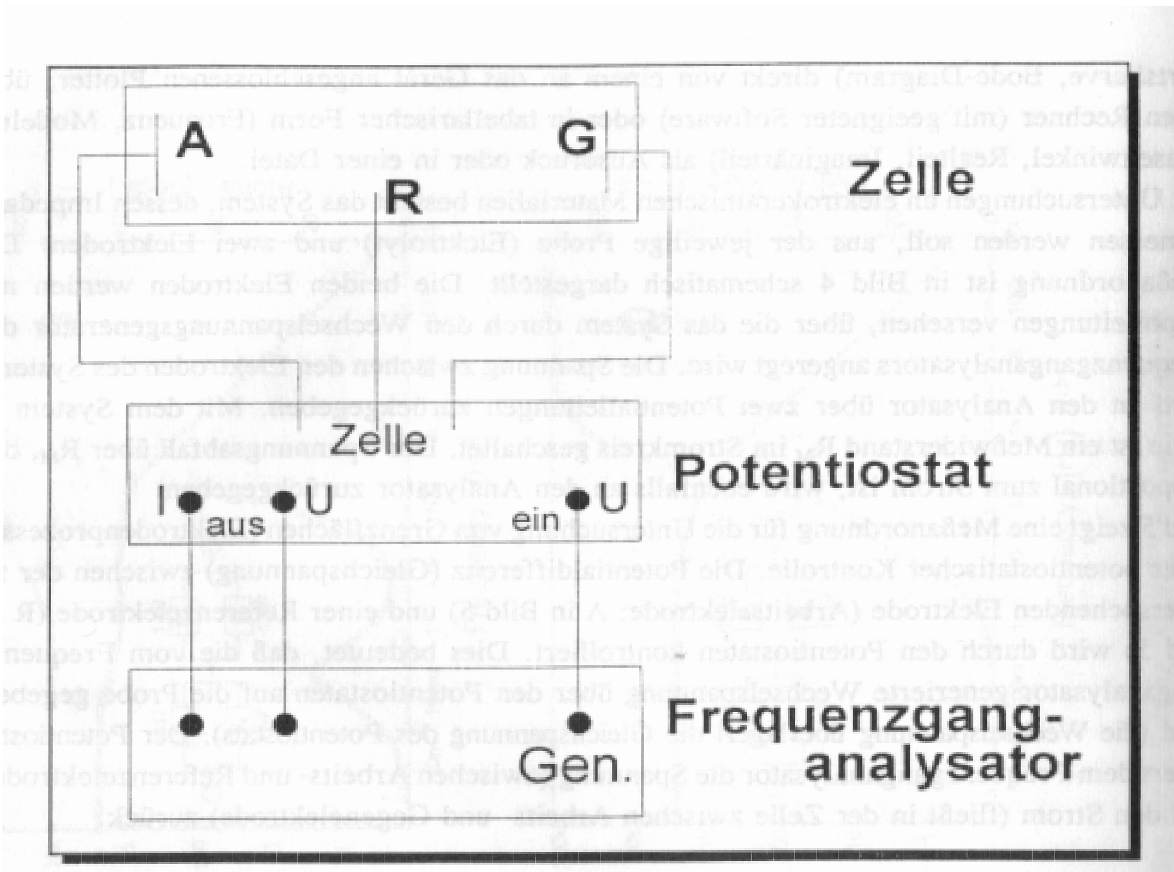

Bild 5. *Meßanordnung für Impedanzspektroskopie unter potentiostatischer Kontrolle*

Fig. 4. Hardware arrangement: Cell, Potentiostat, and Frequency Response Analyzer.

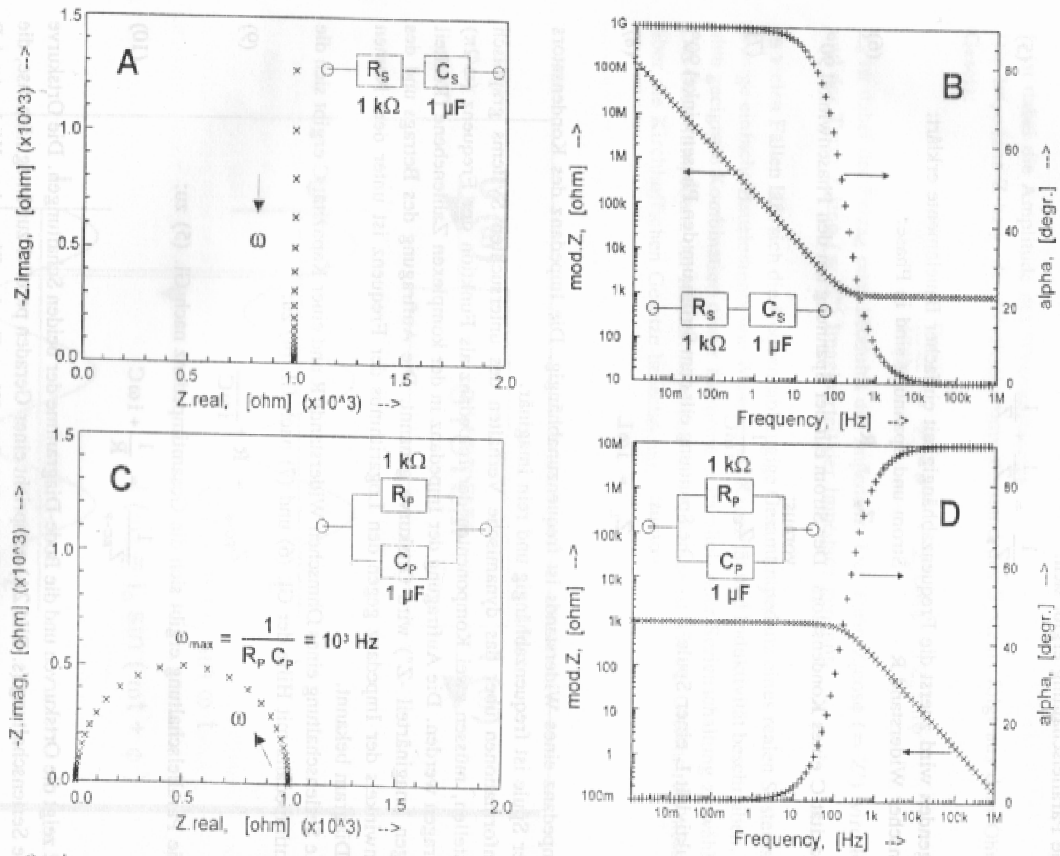

Bild 2. *Ortskurven (A, C) und Bode-Diagramme (B, D) der Impedanz einer RC-Serienschaltung (A, B) und einer RC-Parallelschaltung (C, D)*

Fig. 5. Nyquist plot (A,C) and Bode diagram (B,D) of a serial (A,B) and parallel (C,D) circuit. The free parameter is the frequency ω.

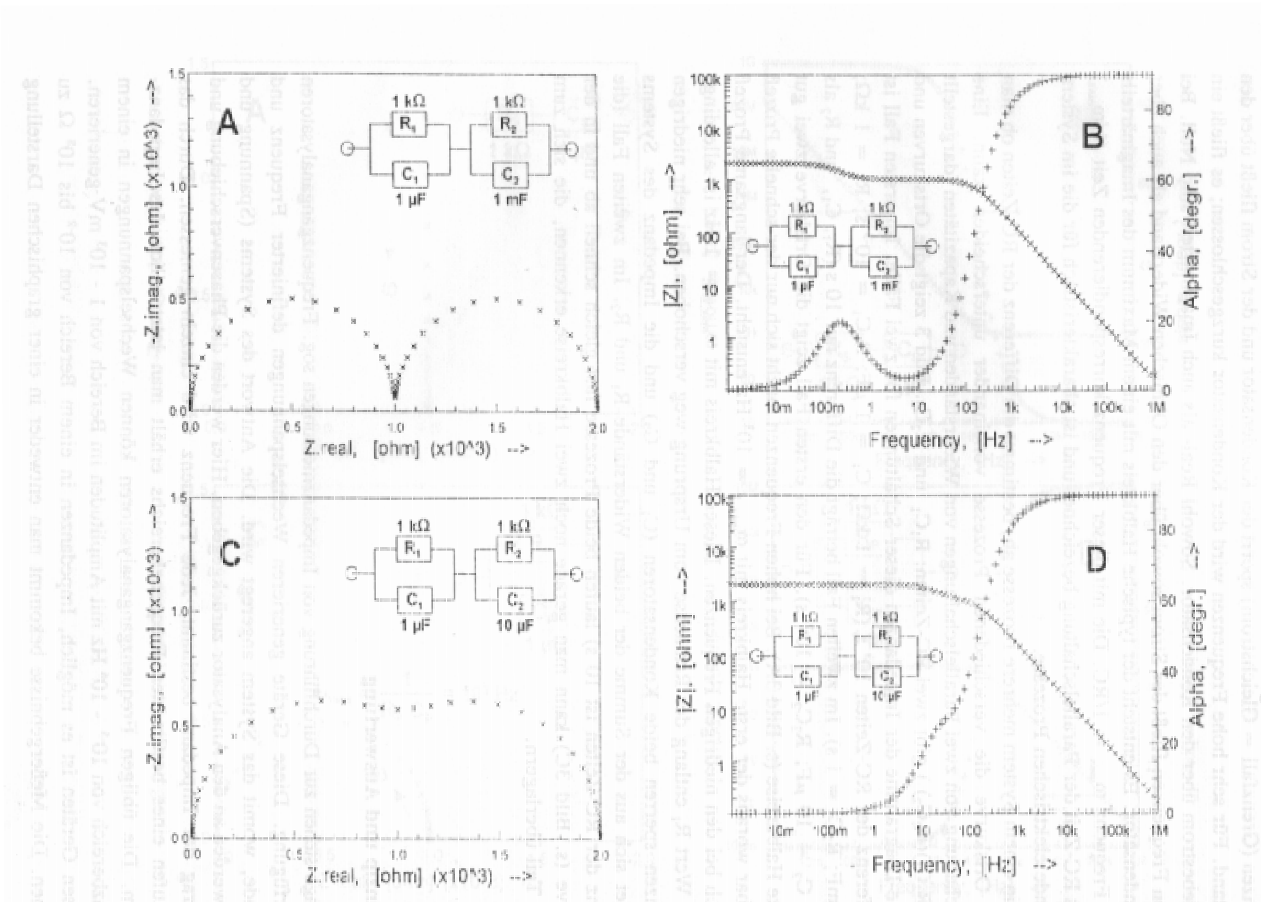

Bild 3. Ortskurven (A, C) und Bode-Diagramme (B, D) der Impedanz der Schaltung (RC)(RC) mit verschiedenen Zeitkonstanten

Fig. 6. Nyquist plot (A,C) and Bode diagram (B,D) of a circuit with 2 different RC time constants.

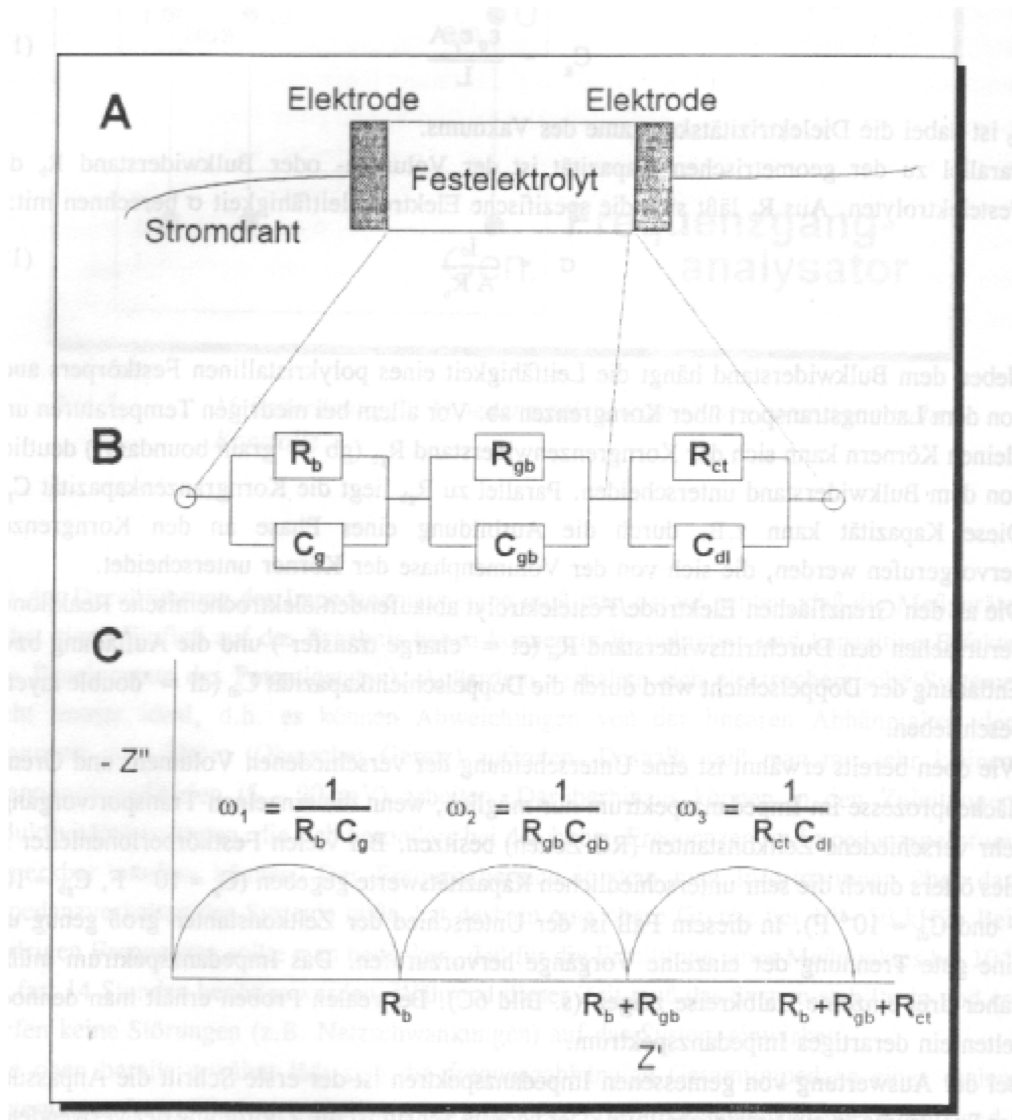

Bild 6. *Ersatzschaltbild (B) für das Festelektrolyt-System (A) und Ortskurve der Impedanz (C)*

Fig. 7. Electrode arrangement (A), electric circuit (B) and impedance plot in Nyquist representation (C). Note: there occur 3 different capacities (**g**eometrical, **g**rain **b**oundary, **d**ouble **l**ayer) and 3 different resitances (electrolyte bulk -, grain boundary -, and charge transfer resistance. In the ideal case, significantly different time constants τ=RC would allow for 3 such separable semi circles.)

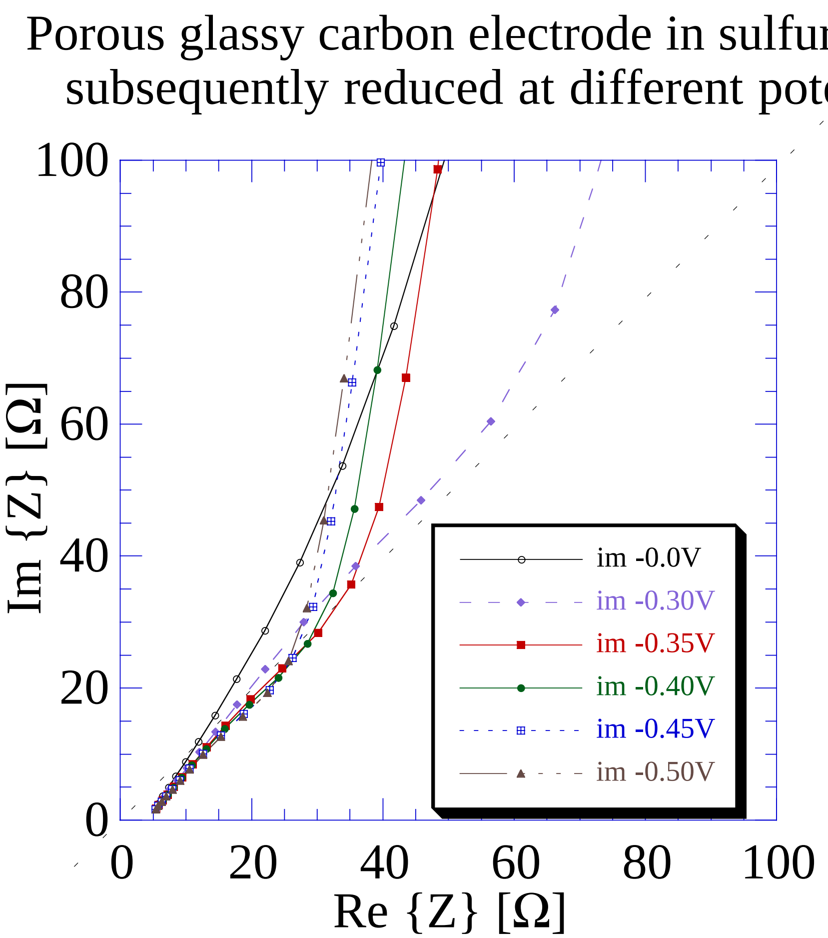

Fig. 8. Impedance of monolithic oxidized glassy carbon. The 45° slope of the impedance (dashed line) is due to a so called Warburg impedance. Subsequent reduction of the porous electrode removes organic quinon/hydroquinon groups from the carbon surface, thus enlarging the pores and lowering the pore diffusion resistance (Warburg impedance). The straight vertical part is due to a pure capacitive behaviour.

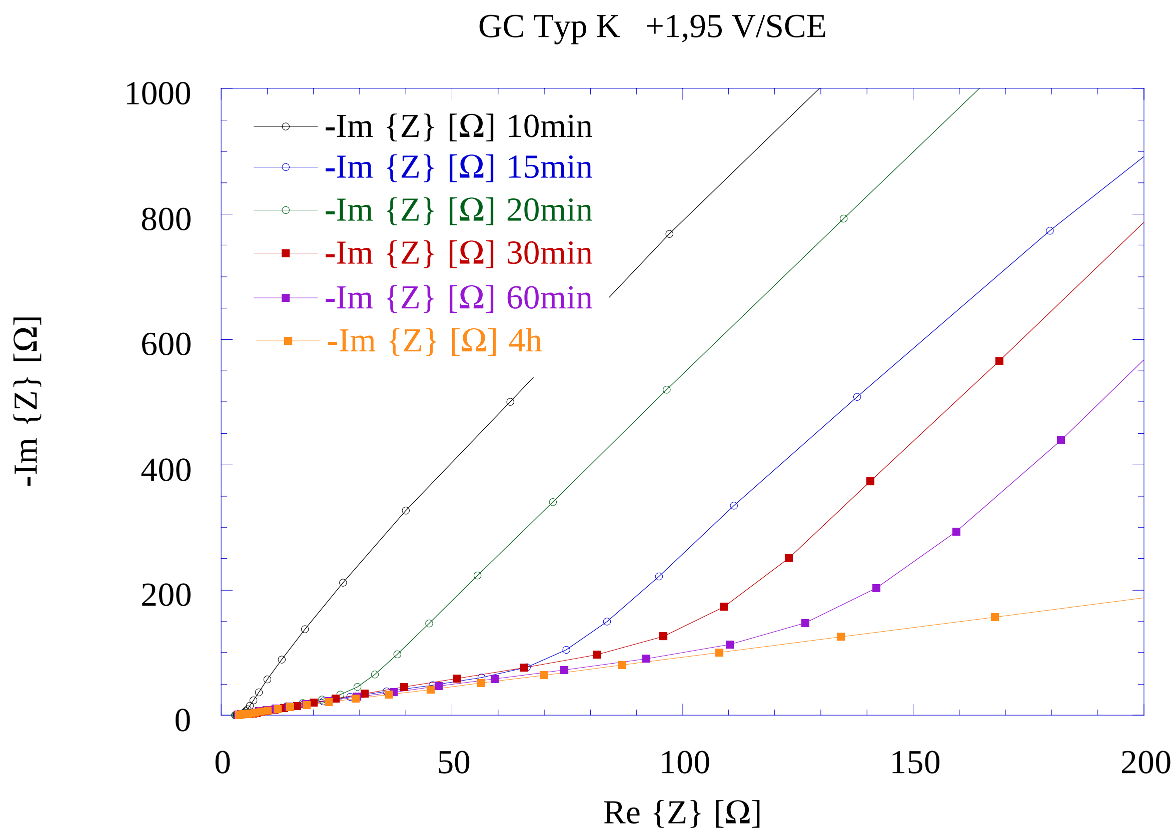

Fig. 9. Impedance of monolithic glassy carbon during activation. Times denote the activation time and thus the thickness of the porous film. The Warburg impedance increases with increasing activation time, because the electrolyte diffusion paths in the pores increase.

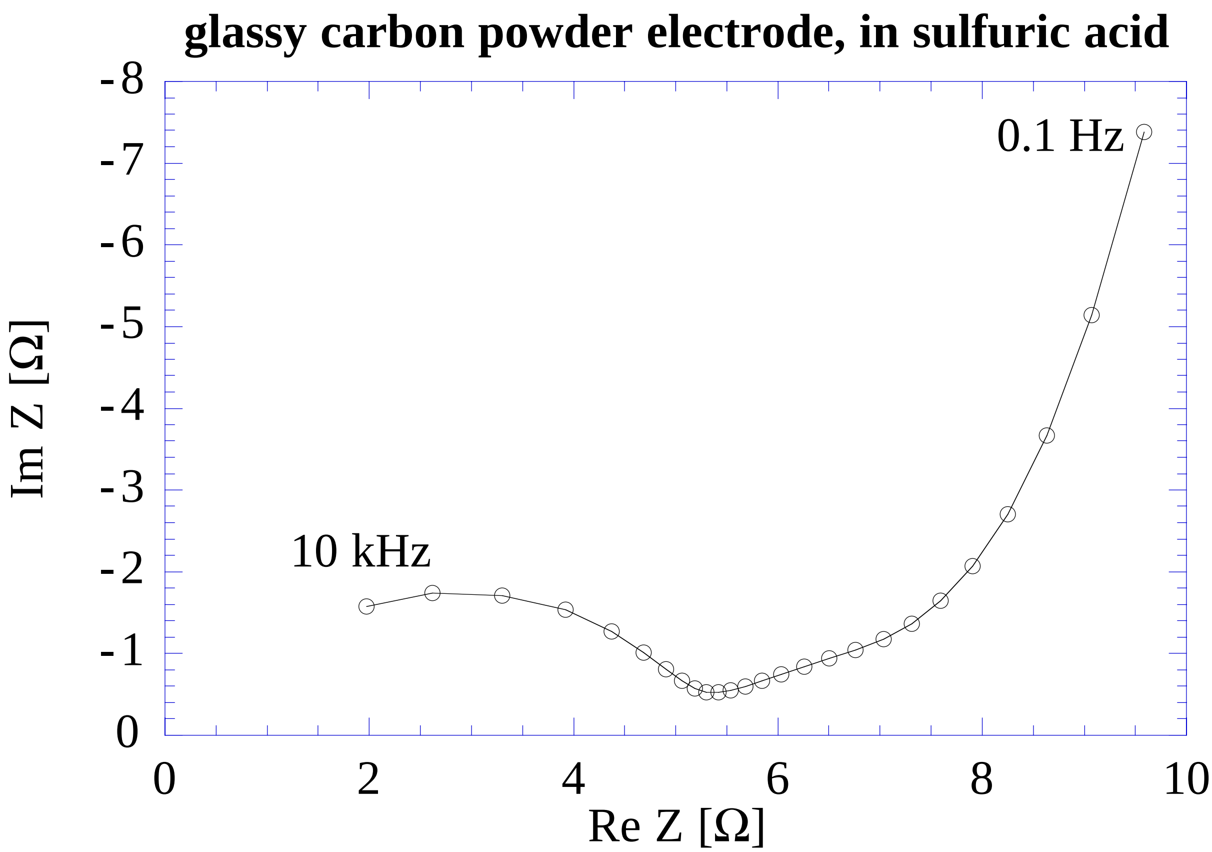

Fig. 10. Impedance of a glassy carbon powder electrode. The semi circle is due to grain boundary resistance. Right beside the semi circle, the 45° Warburg diffusion resistance is observed. Pure capacitive behaviour is observed for very low frequencies.