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Ageing and conductivity of electrodes of high rate RPCs from an ion conductivity approach

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It is well known that electrodes for high rate resistive plate chambers need to show some electrical properties which are more demanding than the low rate ones. As expected from the stationary DC mode, the rate capability is limited by the product d ·ρ ·q, where an avalanche average charge q is depleted by a material of thickness d with a resistivity ρ. Using this approximation, the only free parameter useful for a real optimization is the plate resistivity ρ. Moreover, it has to be stable during the detector lifetime. In order to keep the detector performance at a reasonable level, the electric field inside the gaps is not allowed to fall more than 15% under MIPs radiation; it means roughly φ·ρ ⊠ 1−5, where φ is the particle flux given in kHz/cm2 and the resistivity ρ is given in TΩcm. For instance, coping with particle fluxes as high as 20kHz/cm2, as intended at the CBM experiment at FAIR, will require to use materials having resistivities in the range ρ = (0.05, 0.25)T Ωcm.

It is difficult to find 'well-behaved'materials in this range with no issues on the charge depletion in long times, or without savage electric discharges which can damage seriously both the front-end electronics and the material itself. Several ceramic composites have been built and compared with some materials already used in several timing RPCs. Ceramic RPC plates electric properties have been compared with the electrical response of a classic solid electrolyte in order to understand the ageing phenomena. Thus, simple estimations can be made for determining the maximum RPC working time before instabilities related to inside electrochemical processes arise.

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