The design and development of hybrid organic – inorganic materials with improved electrochemical performance to be used in energy storage applications (e.g. supercapacitors) is presented. The systematic study carried out shows various carbon–based materials working as active substrates where the anchoring of inorganic species takes place (i.e. polyoxometalates, such as $\text{H}_3\text{PMo}_{12}\text{O}_{40}$, PMo$_{12}$) in search of synergic properties[1-3].

One gram of dried activated carbon, AC (kindly supplied by Norit Chemicals®) was added into a 50 ml 10mM $\text{H}_3\text{PMo}_{12}$ aqueous solution. The mixture was stirred for 24 h at room temperature, then filtered, washed and dried at 80 °C for 24h in a vacuum oven [4]. The amount of PMo$_{12}$ impregnated was obtained by weight difference (54 wt.%). The electrochemical characterization of the materials was carried out by cyclic voltammetry and galvanostatic charge – discharge tests. Pt wire and Ag/AgCl were used as counter and reference electrode, respectively, in the 3-electrode set-ups. 1 M H$_2$SO$_4$ was used as electrolyte.

Figure 1 a) shows CVs for AC and the hybrid material. The former shows a typical rectangular shaped capacitive behavior. The hybrid (AC/ PMo12) material shows well – defined redox peaks on top of a rectangular–shaped envelop, indicating the coexistence of double layer and pseudocapacitance in that material. The specific capacitance values of carbon electrodes were improved by following this hybrid approach, not only in terms of, $F/g$, but more importantly in terms of $F/cm^2$, from 10 µF/cm$^2$ in AC to 28 µF/cm$^2$ in AC/PMo$_{12}$, which can be considered more relevant for practical applications. Symmetrical supercapacitors with AC/PMo$_{12}$ electrodes were characterized in synchronous experiments (two- and three- electrode configuration). In such set – up, the cell works as a two electrode cell and the variations of potential of each electrode are monitored. Figure 1 b) shows a galvanostatic cycle (left Y-axis) and the positive and negative electrode potentials (top blue and bottom green line, respectively). Efficiencies ranged 95 – 100% in the range on current tested. The overall cell voltage is split between positive and negative. The stability of the materials was evaluated by means of long-term cycling where a two electrode assembly was cycled over more than 10,000 cycles (1.3 A/g) showing no reduction in capacitance values demonstrating the strong interaction between the carbon substrate and the POM thus, validating the suitability of such material to be used in supercapacitors.

![Graphs](image-url)  
Fig.1. a) CVs - 5mV/s. b) Galvanostatic cycling at 15 mA - 1V (left Y-axis) and positive (top) and negative (bottom) electrode potentials.

**Keywords** Supercapacitors; polyoxometalates