

# Phosphotungstate Nanoclusters enhance the capacitance and energy density of activated carbon in organic electrolyte supercapacitors

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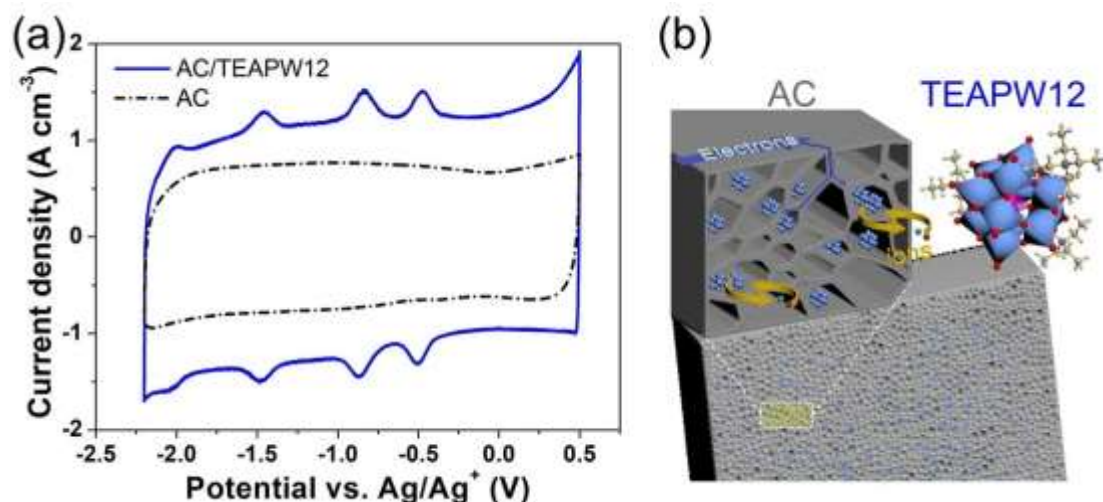
## Abstract

Phosphotungstic acid is a solid acid with reversible electroactivity and as such, we have previously shown how it can work as a faradaic additive to activated carbon (AC) in acidic aqueous electrolytes[1]. Yet, their use in organic media allows not only for added capacity but also higher voltage. We will present our recent work showing how the tetraethylammonium derivative of phosphotungstate  $[PW_{12}O_{40}]^{3-}$  (PW12) can be homogeneously distributed throughout the pores of activated carbon (AC) in organic solvents such as N,N'-dimethylformamide (DMF) and demonstrate the use of this hybrid electrode material in an organic electrolyte (1 M TEABF<sub>4</sub> in acetonitrile) supercapacitor. Our results show the efficient electroactivity of the PW12 cluster even in the absence of protons, providing a higher voltage than aqueous electrolytes and fast and reversible redox activity. The hybrid material shows a combination of double-layer (AC) and redox (PW12) capacities leading to an increase (36%) in volumetric capacitance with respect to pristine AC in the same organic electrolyte (1 M TEABF<sub>4</sub> in acetonitrile)[2]. Remarkably, we were able to quantify this increase as coming predominantly from non-diffusion-limited processes thanks to the small size (1 nm) and utterly dispersed nature of these polyoxometalate (POM) clusters[2]. Moreover, the hybrid material delivers a good rate capability and excellent cycle stability (93% retention of the initial capacitance after 10,000 cycles). This study has a profound significance on improving capacitance of carbon-based materials in organic electrolytes.

## REFERENCES

- [1] Jullieth Suarez-Guevara, Vanesa Ruiz and Pedro Gomez-Romero, Journal of Materials Chemistry A, 4 (2014) 1014-1021
- [2] Jun-jie Zhu, Raul. Benages-Vilau, Pedro Gomez-Romero, Electrochimica Acta, 362 (2020) 137007.

## FIGURES



**Figure 1:** a) Cyclic voltammograms of AC and AC/TEAPW12 at 20 mV s<sup>-1</sup> in three-electrode configuration, b) Schematic diagram of how the anchoring of TEAPW12 on AC allows for fast and reversible redox activity.