# Vine shoots-derived carbon: from Al-ion supercapacitors to Na-ion batteries

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Energy storage systems are the key element of a sustainable energy supply chain, enabling the widespread use of renewable energy sources and providing stability and efficiency in the energy sector. Their role will be increasingly important as the world moves towards more sustainable energy solutions and reduced carbon emissions [1]. In the array of different materials for energy storage, carbon materials are one of the most studied due to their versatile nature and favourable chemistry, along with simple and environmentally friendly synthesis. This talk will explore the possibilities of converting an abundant biomass waste into carbonaceous materials for the next generation of batteries and supercapacitors relying on widely available elements such as sodium and aluminium.

Vine shoots, an abundant by-product of the wine industry, was used as a precursor for obtaining two types of carbon materials. For the use in supercapacitors, a material with a large specific surface area of 1500 $m^2/g$ was developed in a simple two-step process by carbonization/$ZnCl_2$ activation of vine shoots at lower temperature of 700 °C. Such obtained activated carbon exhibits its typical pseudocapacitance behaviour in a non-conventional Al-ion based aqueous electrolyte. This enabled broadening the operating voltage of carbon to ≈1.8 V and reaching specific capacitance ≈216 F $g^{-1}$ and energy density of ≈24 Wh $kg^{-1}$ at 1 A $g^{-1}$ in symmetric supercapacitor configuration [2]. To develop carbon material which configures in batteries, vine shoots were simply carbonized at higher temperatures yielding low specific surface area non-graphitizable carbon (hard carbon, HC), favourable for insertion of large amount of Na-ions. Optimized HC electrode showed high capacity vs. Na in $NaPF_6$/EC+ +DMC+2%FEC electrolyte, with ≈270 mAh $g^{-1}$ at 37.2 mA $g^{-1}$ and ≈253 mAh $g^{-1}$ at 372 mA $g^{-1}$, low voltage and excellent cyclic stability. By pairing developed HC anode with commercial NVPF [$Na_3V_2(PO_4)_2F_3$] cathode in a HC//$NaPF_6$/EC+ +DMC+2wt%FEC//NVFP/C cell we developed a ≈4 V Na-ion battery with a reversible capacity of ≈54 mAh $g^{-1}$ at 153.6 mA $g^{-1}$ (per cathode mass), capacity retention of 92 % after 100 cycles and energy density of ≈216 Wh $kg^{-1}$ at 153.6 mA $g^{-1}$. This lecture will address the relations between alternative ions storage performance and structural/textural properties of carbon contributing to setting possible directions towards simple design of high performance electrodes for the next generation of energy storage devices.

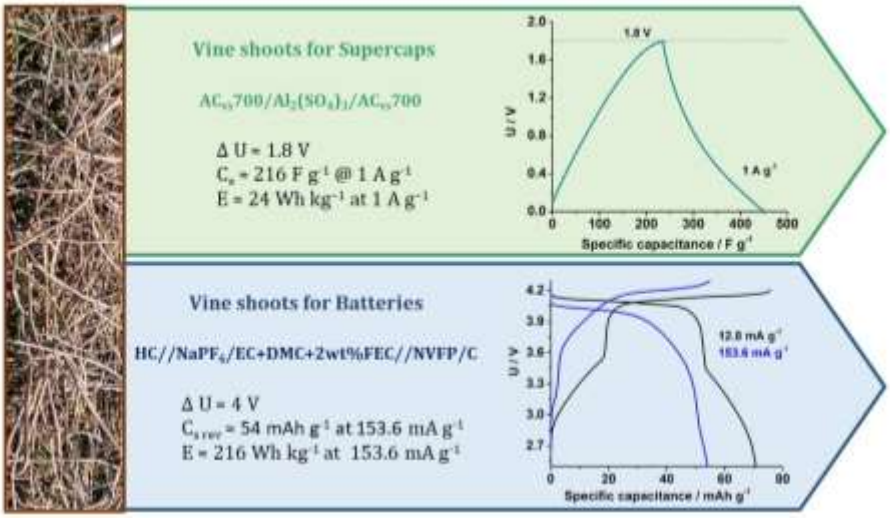


*Figure 1. Next generation of energy storage systems based on vine shoots-derived carbon*

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## References

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