

1 **Supporting Information**

2 **Sustainable AgFeO₂–Carbon Nanohybrids derived from Agricultural Waste for**
3 **High-Performance Supercapacitors in Alkaline Environments and Multifunctional**
4 **Biomedicine**

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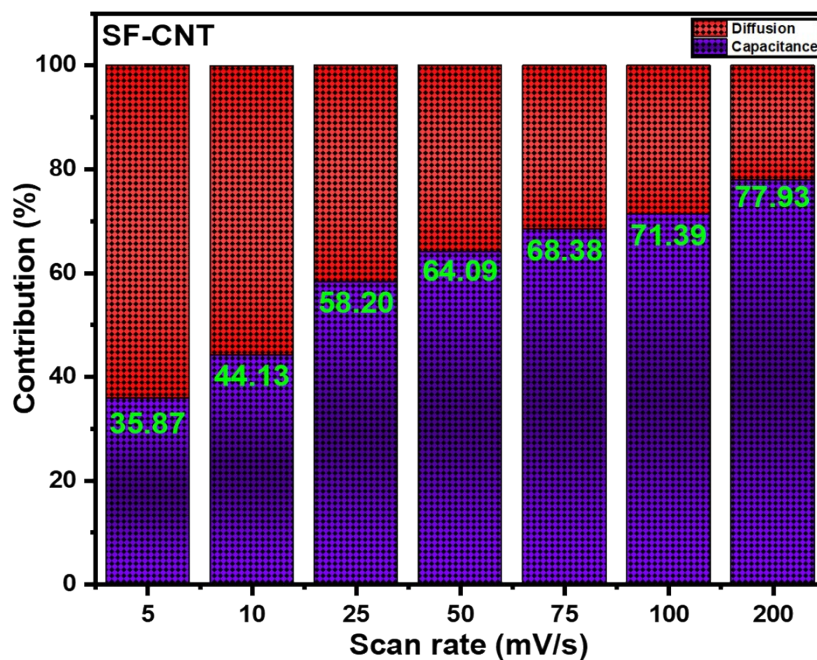
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15 **Electrochemical Kinetics Analysis**

16 The capacitive and diffusion-controlled contributions to the total charge storage were
17 quantified using the power-law relationship, typically expressed as $i(V) = k_1v + k_2v^{1/2}$. As
18 illustrated, a distinct transition in the charge storage mechanism is observed as the scan rate
19 increases. At the lowest scan rate, the diffusion-controlled process contributes 64.13 % of
20 the total capacity, indicating that the electrolyte ions have sufficient time to penetrate the
21 bulk lattice or undergo slow faradaic reactions.

22 However, as the scan rate progresses, the capacitive contribution increases from 35.87 %
23 to a dominant 77.93 %. This trend signifies that at higher power densities, the surface-
24 controlled processes comprising both double-layer capacitance and surface pseudo
25 capacitance dictate the electrochemical performance. The sharp increase in capacitive
26 contribution between 44.13 % to 58. 20% intervals mark the threshold where the system
27 shifts from a diffusion-limited to a surface-controlled regime. This high capacitive
28 contribution at higher scan rates is a hallmark of excellent rate capability. It suggests that
29 the electrode material possesses a highly accessible surface area and shortened ion diffusion
30 paths, making it an ideal candidate for high-power energy storage applications where rapid
31 charge-discharge cycles are required. This analysis is performed using the Dunn's method,
32 based on the power-law equation (1).

33 $i(V) = k_1v + k_2v^{1/2}$ (1)



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35 **Fig. S1.** Kinetic analysis of the charge storage mechanism. Normalized contribution ratio
 36 of surface-controlled capacitive and diffusion-limited processes at varying scan rates (5-
 37 200 mV/s), derived via the Dunn's method.

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39 **References:**

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 41 *Chemistry Chemical Physics*, 2026, **28**, 4007–4022.

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