S1. Synthesis of binary composites $m_K$-BN/CNT and $m_H$-BN/CNT

To synthesize $m_K$-BN/CNT binary composite, initially 0.05 g $m_K$-BN and 0.05 g CNT were added with 50 ml deionized water in a 100 ml beaker. Then it was sonicated for 30 minutes to disperse properly. After that the resulting dispersed mixture was filtered and dried in an electric oven. For $m_H$-BN/CNT binary composite, same procedure was followed. Here $m_H$-BN was used in place of $m_K$-BN.

Figure S1. EDS analysis of (a) BN (b) $m_H$-BN, and (c) $m_K$-BN.
Figure S2. FTIR spectra of $m_{H}$-BN/CNT, and $m_{K}$-BN/CNT.
Figure S3. TEM images of mK-BN/CNT/PANI in lower (a, b) and higher magnification (c, d).
Table S1. Calculated specific surface area, total pore volume and pore diameter of modified boron nitride and ternary composites:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Specific surface area (m²/g)</th>
<th>Total pore volume (cc/g)</th>
<th>Average pore diameter (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mₖ-BN</td>
<td>50.49</td>
<td>0.094</td>
<td>3.301</td>
</tr>
<tr>
<td>mₜ-BN</td>
<td>42.14</td>
<td>0.079</td>
<td>3.92</td>
</tr>
<tr>
<td>mₖ-BN/CNT/PANI</td>
<td>93.35</td>
<td>0.130</td>
<td>3.130</td>
</tr>
<tr>
<td>mₜ-BN/CNT/PANI</td>
<td>89.77</td>
<td>0.119</td>
<td>5.404</td>
</tr>
</tbody>
</table>
Figure S4. XPS (a) Survey plot, and (b) C 1s spectra of mK-BN/CNT/PANI; (c) Survey plot, and (d) C 1s spectra of mH-BN/CNT/PANI.
Figure S5. CV plots of (a) BN (b) m_{H}-BN (c) m_{K}-BN, and (d) m_{H}-BN/CNT/PANI at different scan rates (2-10 mV/s) in 1M aqueous KCl solution as electrolyte in three electrode system.

S2. Trasatti Method Analysis

To calculate the electron double layer and pseudocapacitive contribution to the overall capacitance of the electrodes, Trasatti method is applied. This theoretical analysis was carried out by using the following steps.

The areal capacitances of the ternary composites were calculated by using the following equation:

\[
C = \frac{S}{2. \Delta V \cdot v}
\]  

(Equation S1)
Here $C$ corresponds to the areal capacitance (in mF/cm$^2$), $\Delta V$ is the potential range (in V), $S$ denotes the area enclosed by corresponding cyclic voltammograms (in mA·V/cm$^2$) and $v$ corresponds to the scan rate (in V/s). It is assumed that the ion diffusion follows a semi-infinite diffusion pattern, which means the reciprocal of the calculated areal capacitances ($C^{-1}$) and the square root of the scan rates ($v^{1/2}$) should be in linear co-relationship.$^{[1]}$ (Figure S6. For BN, m$_H$-BN, m$_K$-BN, m$_H$-BN/CNT/PANI, and m$_K$-BN/CNT/PANI)

\[
C^{-1} = \text{Constant}. \ V^{1/2} + C_T^{-1}
\]  

(Equation S2)

Here $C_T$ denotes the maximum capacitance, which can be the sum of electron double layer capacitance and pseudocapacitance and calculated from the intercept in the Y-axis of $C^{-1}$ Vs. $v^{1/2}$ plot.$^{[2]}$ For this case, also the calculated areal capacitances show the linear relationship with the reciprocal of the square root of the scan rates presuming a semi-infinite diffusion pattern.$^{[3]}$ (Figure S7. For BN, m$_H$-BN, m$_K$-BN, m$_H$-BN/CNT/PANI, and m$_K$-BN/CNT/PANI)

\[
C = \text{Constant}. \ V^{-1/2} + C_{EDL}
\]  

(Equation S3)

Here, $C_{EDL}$ is the utmost electron double layer capacitance and it can be calculated from the extrapolated intercept in Y-axis.$^{[3]}$ the Subtraction value of maximum electron double layer capacitance ($C_{EDL}$) from maximum capacitance ($C_T$) gives the maximum pseudo-capacitance ($C_{ps}$). So, the capacitance contribution can be calculated by using following equation:

\[
\%C_{EDL} = \frac{C_{EDL}}{C_T} \times 100
\]  

(Equation S4)
\[ C_{PS}\% = \frac{C_{PS}}{C_T} \times 100 \]  

(Equation S5)

Figure S6. Plots of reciprocal of areal capacitance \((C^{-1})\) vs. square root of scan rate \((v^{1/2})\) of (a) BN, (b) mH-BN (c) mM-BN, (d) mH-BN/CNT/PANI, and (e) mM-BN/CNT/PANI.
Figure S7. Plots of areal capacitance ($C$) vs. reciprocal of square root of scan rate ($v^{-1/2}$) of (a) BN, (b) $m_H$-BN (c) $m_K$-BN, (d) $m_H$-BN/CNT/PANI, and (e) $m_K$-BN/CNT/PANI.

Figure S8. Bar plot of percentage of capacitance contribution evaluated for (a) BN & $m_K/m_H$-BN, and (b) $m_H$-BN/CNT/PANI & $m_K$-BN/CNT/PANI.
Figure S9. Bar plot of specific capacitance, energy density and power density of $m_H$-BN/CNT, $m_K$-BN/CNT, $m_H$-BN/CNT/PANI, and $m_K$-BN/CNT/PANI in 1M aqueous KCl solution as electrolyte in three electrode system.
Figure S10. Cyclic stability curves of m$_{\text{H}}$-BN/CNT/PANI and m$_{\text{K}}$-BN/CNT/PANI composites up to 1000 cycles in 1M aqueous KCl solution as electrolyte in three electrode system.

S3. Device fabrication

Preparation of Cathode: m$_{\text{H}}$-BN/CNT/PANI along with carbon black (CB) and binder PVDF in the weight ratio (80:15:5) was thoroughly grinded with NMP solvent. The obtained paste was coated over 2x4 cm carbon fiber (current collector) and dried overnight, which acted as the cathode for the supercapacitor device.
**Preparation of Anode:** CB and PVDF in the ratio 90:10 were thoroughly mixed with NMP solvent. The paste was coated over 2x4 cm carbon fiber (current collector) and dried overnight, which acted as the anode for the supercapacitor device.

**Device set-up:** The cathode and the anode were assembled together with tissue paper as the separator which was then pressed using G-Clamp and 1M TEABF₄ in DMSO as well as 1M TEABF₄ in acetonitrile (ACN) were used as the electrolyte. All electrochemical analysis was performed in Biologic SP 300 instrument.

![Figure S11. Schematic representation of ASC device.](image-url)
Figure S12. Electrochemical performance of the ASC in 1M TEABF$_4$/Acetonitrile: (a) CV plots at different potential windows at a constant scan rate of 50 mV/s, (b) CV plots at different scan rates within the potential window of 0 to 2.0 V, (c) GCD plots at different potential windows at a constant current density of 2 A/g, (d) the GCD plots at different current densities within the potential window of 0-2.0 V, and (e) fitted Nyquist plot.
**Figure S13.** Demonstrations of the practical application of the devices with respect to time during discharging (two ASC devices were connected in series): (a) charging set up of the devices and glowing of 43 red LEDs with the logo of IIT-ISM, (b) charging set up of the devices and lighting of 4 V LED strip, and (c) charging set up of the devices and running of 2V fan.

**References:**