



### Low Temperature Growth of Graphene on Ultralong CuNW for Transparent Electrode Applications in Harsh Environments

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#### ABSTRACT:

We successfully synthesized ultralong Cu NW by simple chemical route with high aspect ratio (length 100  $\mu\text{m}$  and diameter 50 nm). Large scale transparent electrodes were prepared on glass and flexible substrates by vacuum filtration method and achieved direct coating of graphene on it by low temperature CE-CVD in 400°C. The as prepared Cu NW TCE reveals high sheet resistance and after graphene coating we achieved low sheet resistance (9.9  $\Omega/\text{sq}$  at 85% transmittance). The graphene coated CuNW were stable more than 15 min in sea water (PH 8.3) which shows the high anti corrosion effect than pure CuNW electrode.

#### EXPERIMENT AND RESULTS:

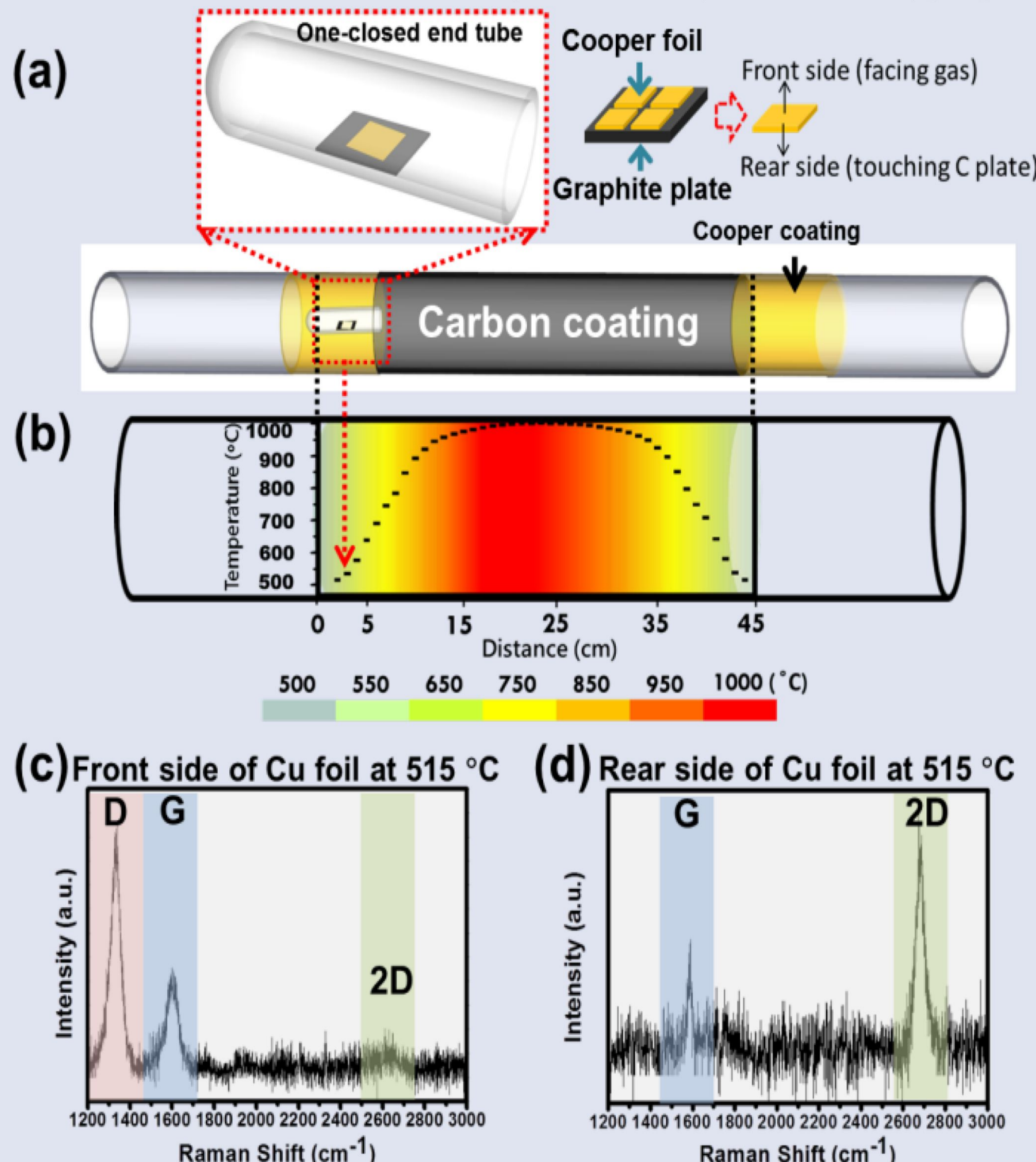


Figure 1. (a) Schematic of experimental setup for CE-CVD graphene growth. (b) Temperature distribution in the furnace at a set point of 1000 °C. Raman spectra of graphene grown on (c) the front side of Cu foil and (d) the rear side of Cu foil at ~500 °C\*.

\*ref: Chem. Mater. 2015, 27, 1646–1655

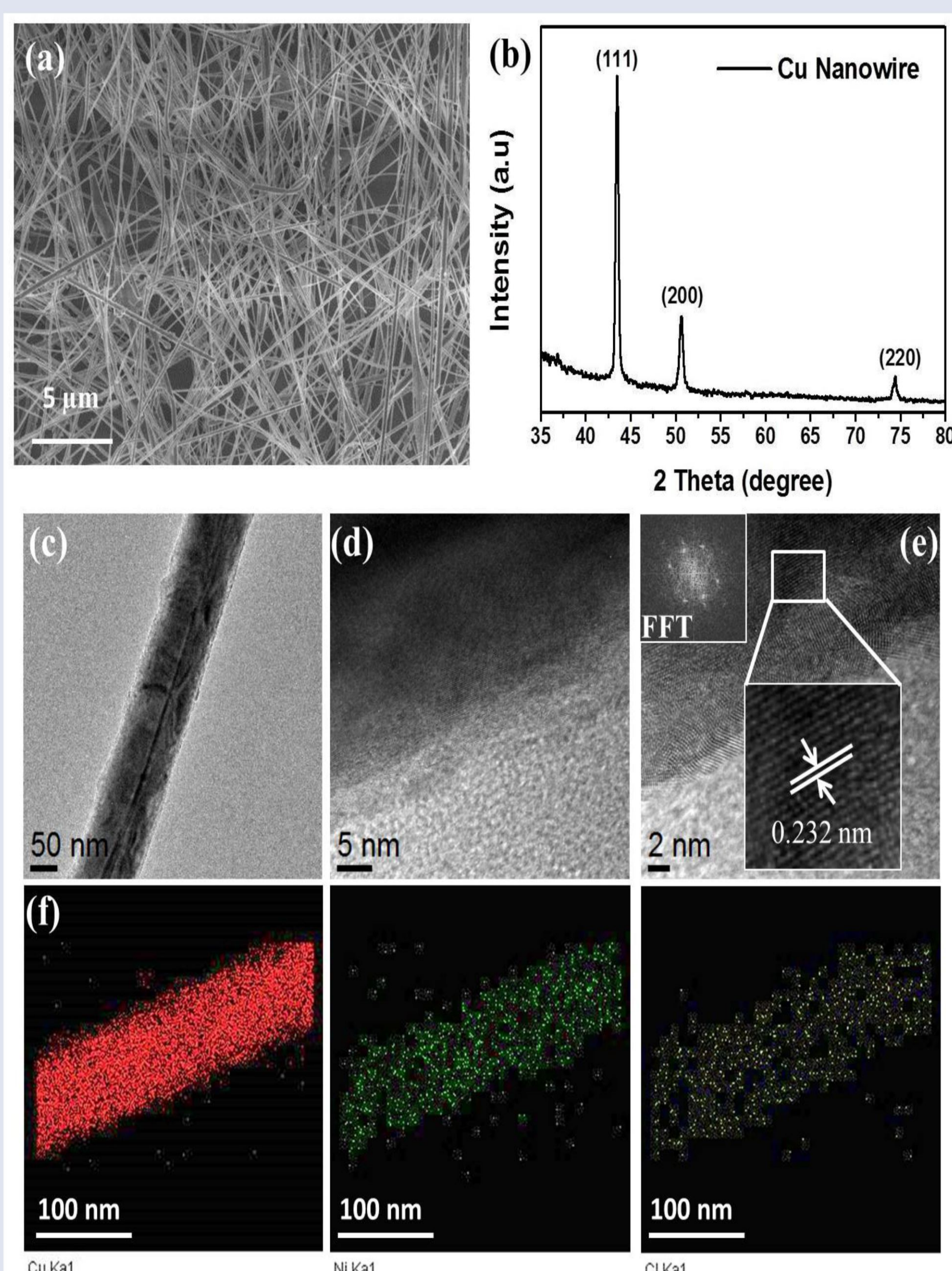


Figure 2. (a) SEM and (b) XRD of as prepared Cu NW (c-e) TEM and HrTEM image and (f) EDX mapping corresponds to Cu, Ni and Cl.

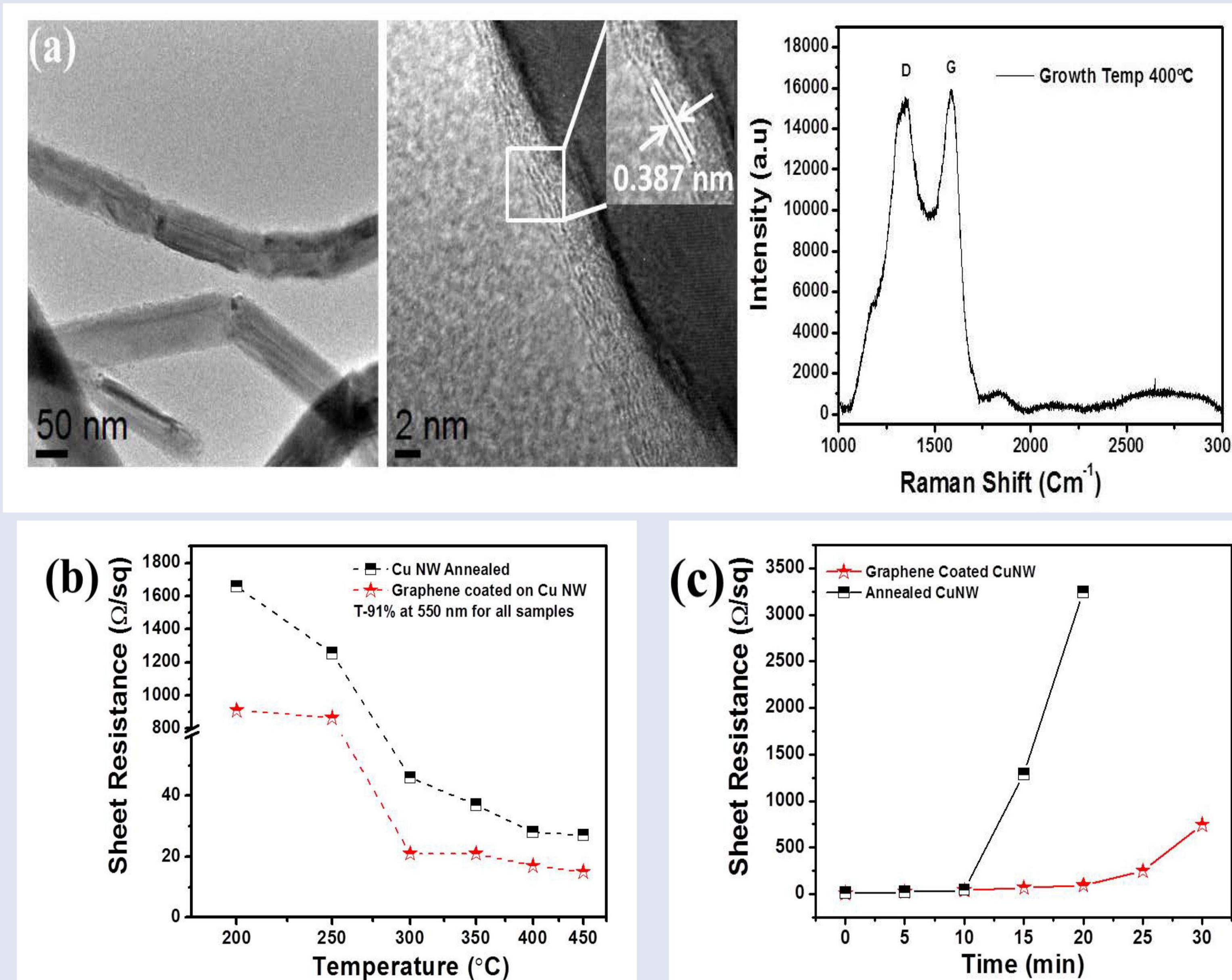


Figure 3. (a) TEM image of graphene on CuNW coated at 400°C, and its corresponding RAMAN spectra (b) Sheet resistance Vs Temperature of annealed and graphene coated NWs and (c) Sheet resistance Vs Time of annealed and graphene coated Cu NW TCE in sea water (PH 8.3)

#### DISCUSSION AND CONCLUSION:

- We prepared high aspect ratio CuNW (L-100 $\mu\text{m}$  and D-50 nm) by simple chemical route shown in fig 2 (a) and its XRD, TEM shown in (b) to (f) reveals as prepared NW were highly crystalline and its surface were covered with Cl and Ni.
- We successfully grown graphene on CuNWs TCE at 400°C on glass substrates to avoid the transfer process in the industries by utilizing the catalytic ability of graphite plate and surrounding carbon, to lower the deposition temperature of graphene without the necessity of expensive and complicated facilities. Fig 3 (a) shows its low magnification TEM and HrTEM images which proves graphene coating on Cu NW and RAMAN spectra shows high crystalline D and G bands of graphene.
- Also we demonstrated anti-corroded TCE of Cu and Cu-gr NW in sea water shown in fig 3 (c) . Graphene coated electrode reveals high anti corrosion effect.
- In conclusion we demonstrates low temperature graphene growth by CECVD process on Cu NW as TCE which shows low sheet resistance 9.9  $\Omega/\text{sq}$  at 85% of transmittance and also it shows excellent anti-corrosion effect in the presence of sea water (PH 8.3).