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Graphene field effect transistor on liquid polymer

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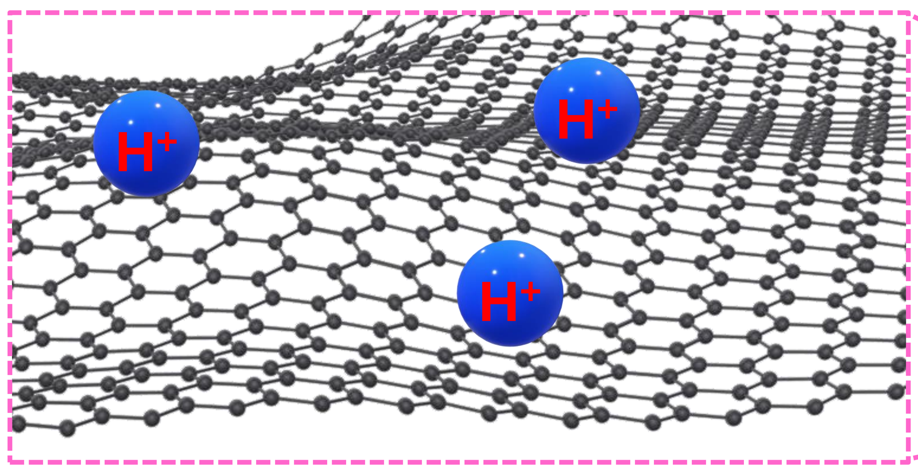
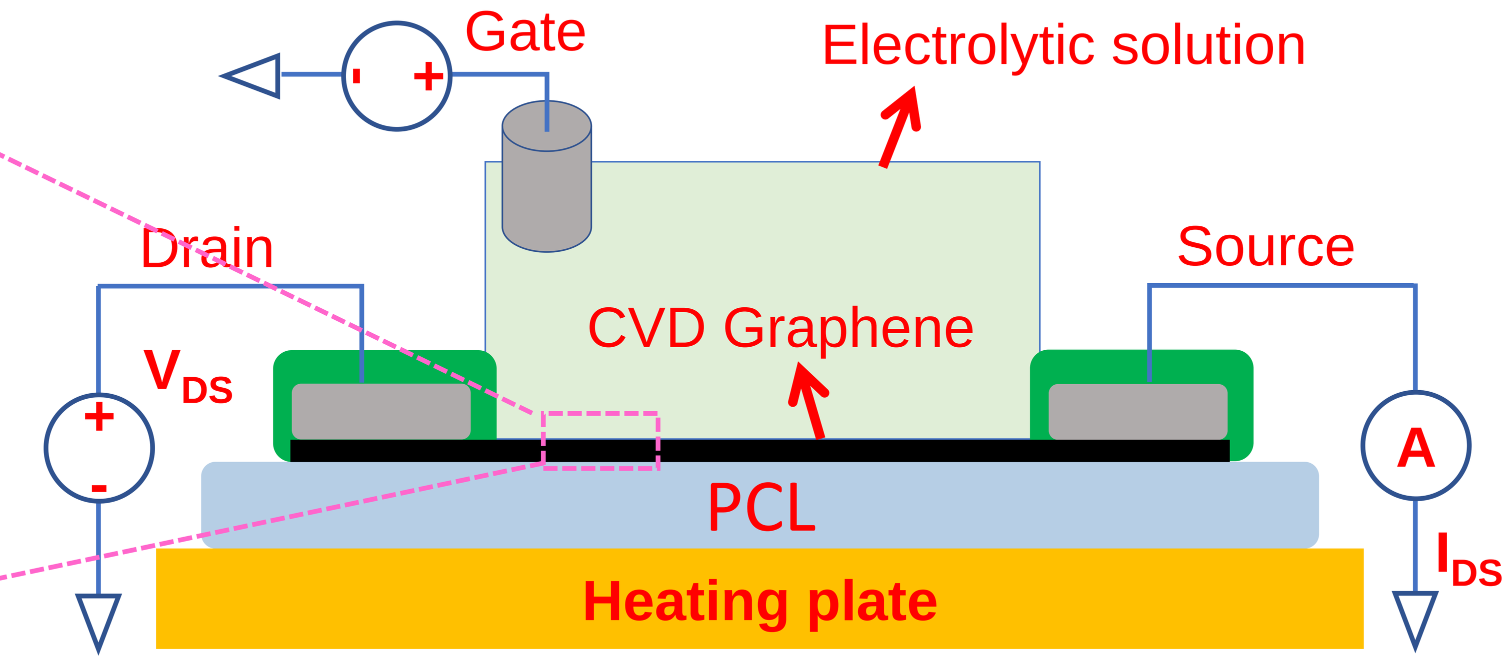
Abstract:

Usually, graphene field effect transistors (GFETs) are fabricated on solid substrates, [1] in which uneven strain and stress are often introduced onto graphene. Herein, we used the polycaprolactone (PCL) polymer with a melting point of 60 ℃ as the substrate of the GFET, as called GFET/PCL, to explore the potential in improving the sensing performance of liquid supported GFET.

Mechanism :

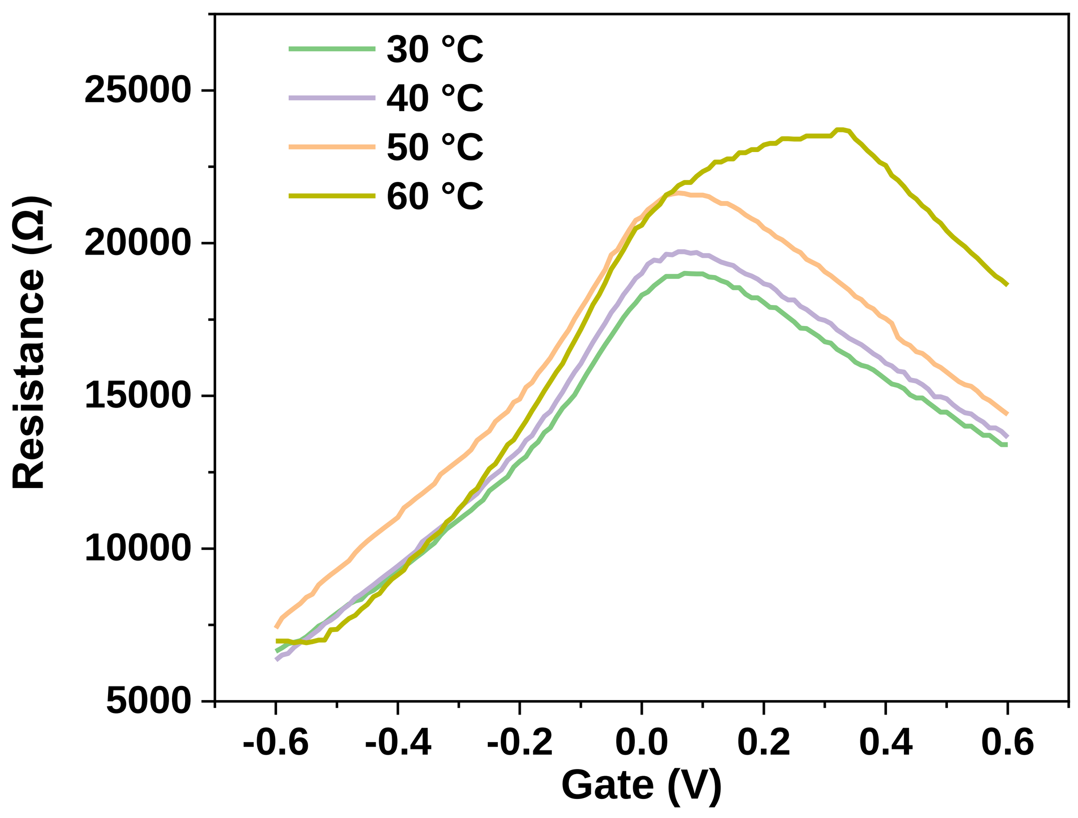
By using sequential heating and cooling cycles (above and below the thawing temperature of the PCL), we expect the polymer to release the inhibit stress included in graphene by the growth. We consequently measured the electrical propriety of graphene in a liquid gated GFET architecture and its pH sensing response.

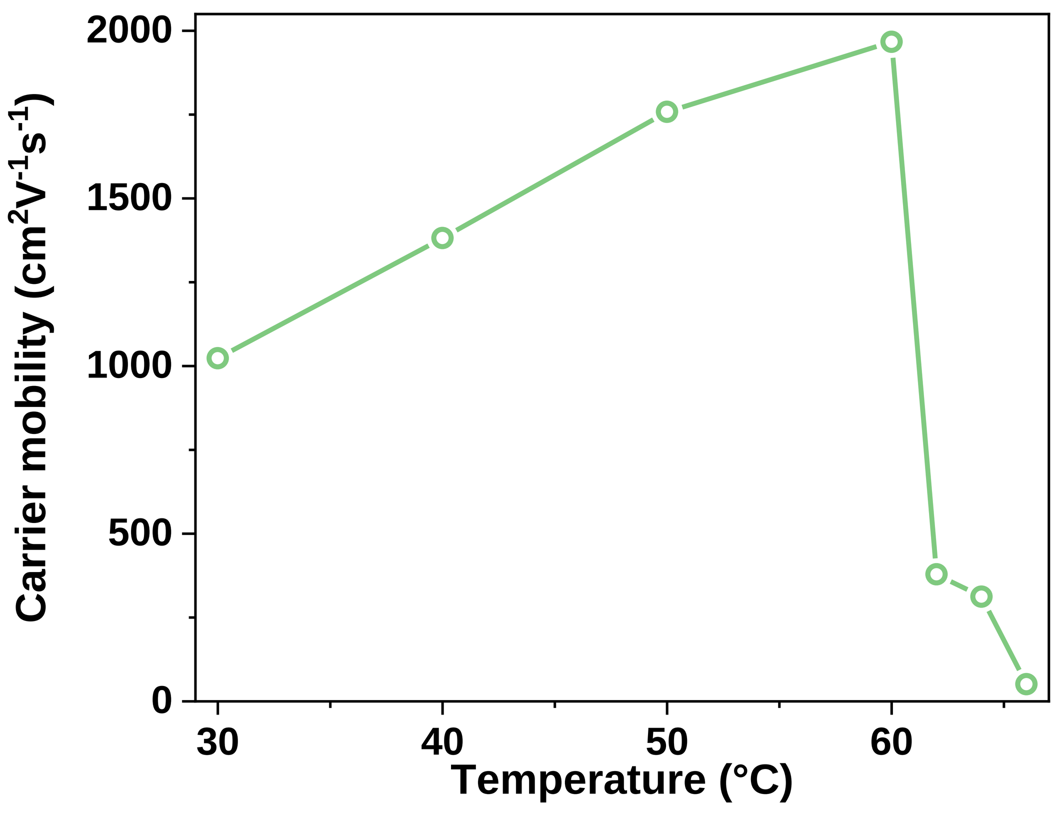




The electrical setup of GFET/PCL for pH solution testing

Results:

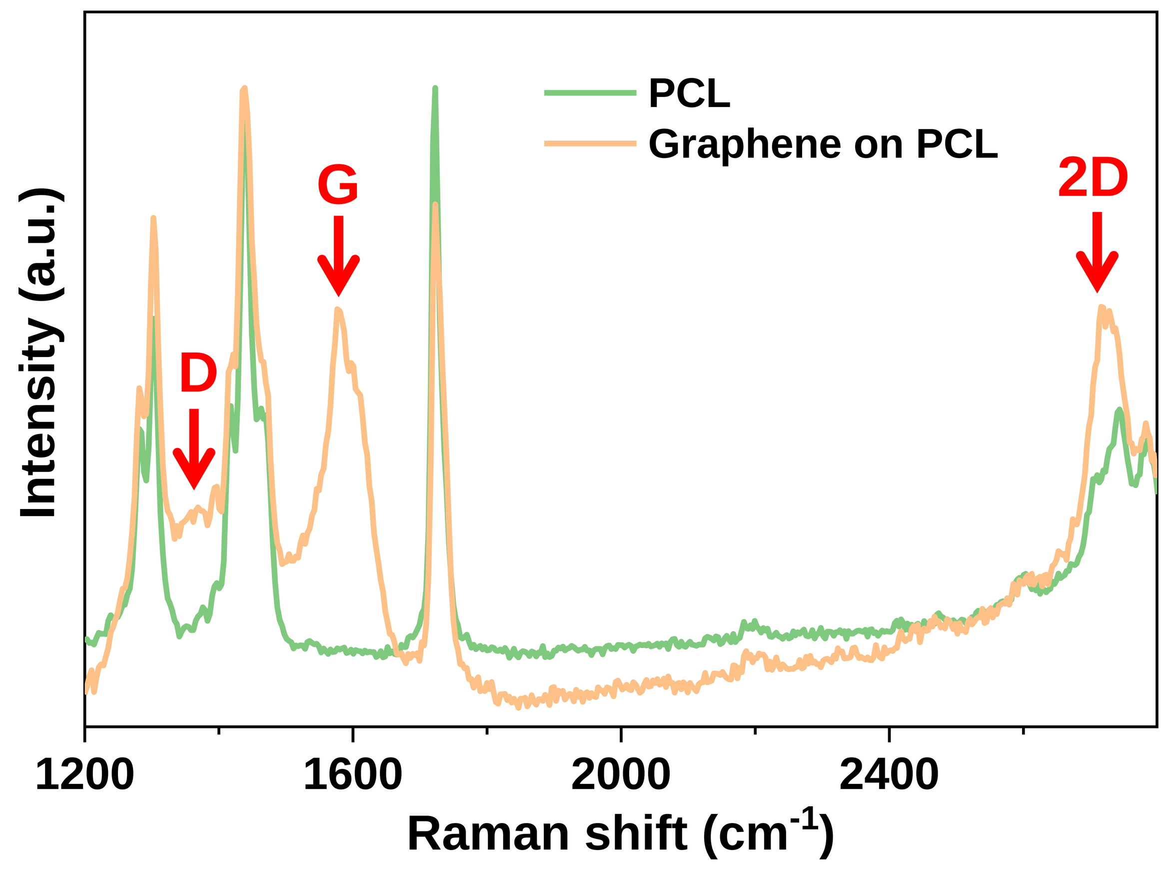




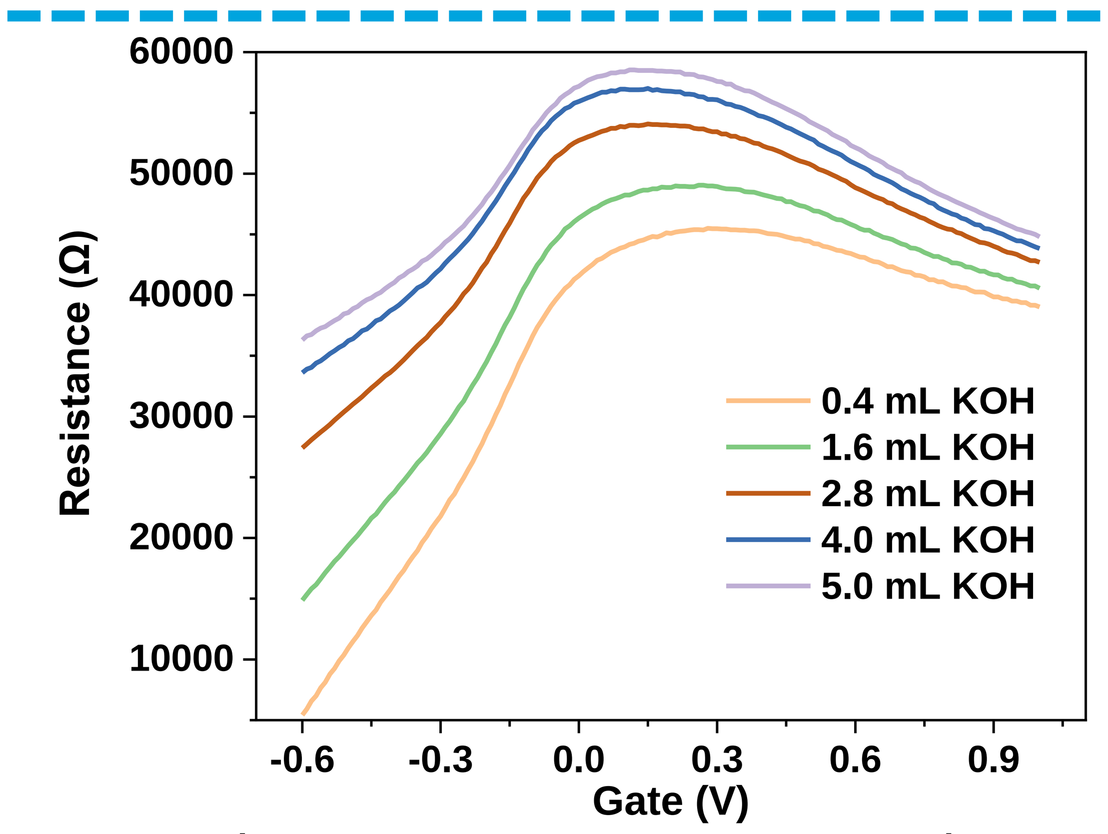
The transfer curve of GFET/PCL moved slowly upward as the temperature gradually raised. When it started to reach the melting point at 60 °C, the transfer curve showed a big change. Its carrier mobility increased as well. We know that temperature has little effect on the carrier mobility of graphene, so it can be inferred that the PCL polymer substrate releases the stress in graphene and improve its carrier mobility when it changes from solid to liquid [2].

When the temperature exceeds the melting point, PCL melts quickly and release gas, leading to the uneven surface and destroying the graphene on it. We can see a rapid increase in resistance and a rapid decrease in carrier mobility.

By comparing the GFET on solid PCL with it on liquid PCL, we found that the liquid substrate release the inhibit stress included in graphene by the CVD growth and enhances its carrier mobility. In the future, stress-relieved graphene will bring higher performance to GFETs.



By comparing the Raman spectra of PCL and graphene on PCL, the good quality of graphene can be revealed.



The pH sensing response was measured at 60 °C. The transfer curve changes regularly as the content of KOH increases, demonstrating that GFET/PCL can detect the amount of KOH and the pH as well.

Conclusions:

Firstly, carrier mobility of GFET/PCL reaches its highest at the melting point of polymer, which is interesting and has potential for application. Secondly, as the amount of KOH increases, the transfer curve of GFET/PCL show regular changes, which can indicate the changes in the amount of KOH and the pH as well.

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REFERENCES

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[2] Belyaeva, L.A., Jiang, L., Soleimani, A. et al. Liquids relax and unify strain in Graphene. Nat Commun 11, 898 (2020).

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