Electronic Supplementary Information

Highly-selective Synthesis of Trimetallic PtRuCu Nanoframes as Robust Catalysts for Methanol Oxidation Reaction

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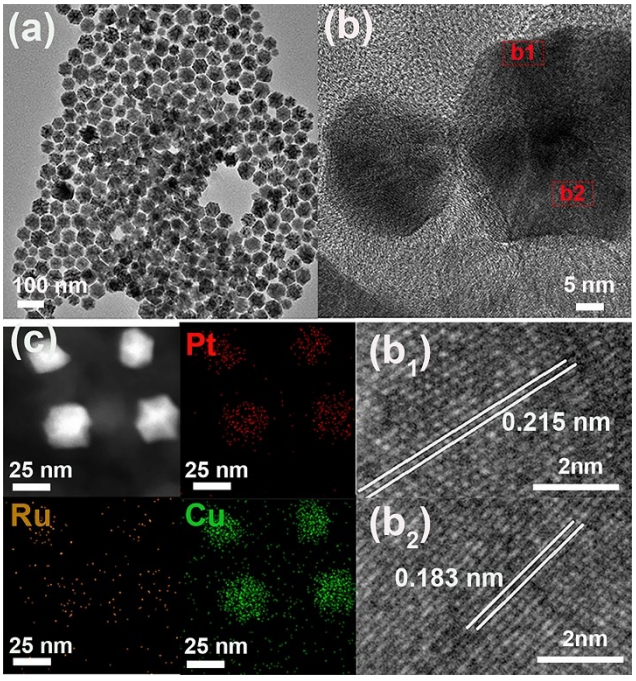

Fig. S1. (a) TEM, (b) HRTEM, (c) HAADF-STEM images and EDS 2D element mappings of PtRuCu NPs.

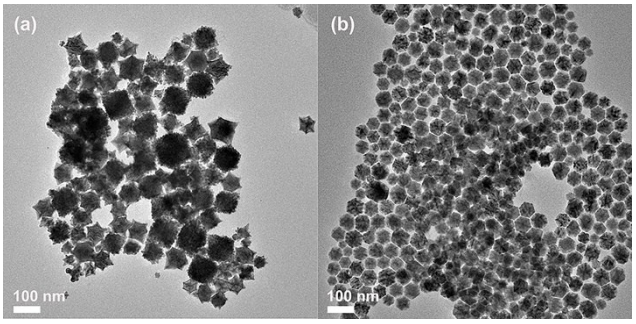

Fig. S2. TEM image of PtRuCu NPs with different pre-mixing time in 200 °C: (a) 0 min, (b) 20 min.

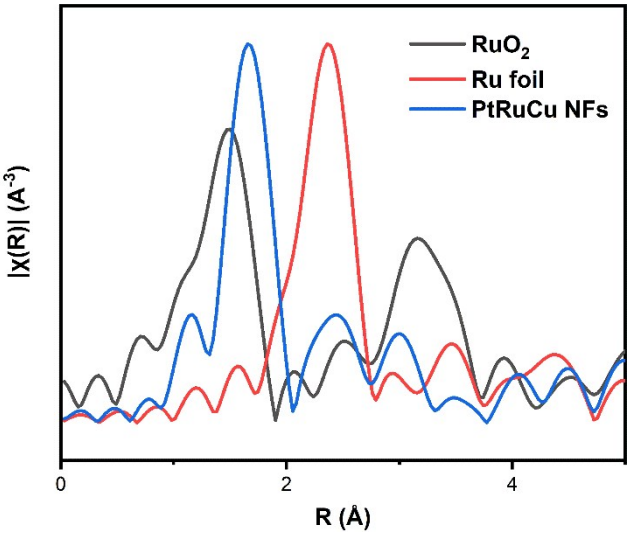

Fig. S3. EXAFS spectra of the Ru K edge.

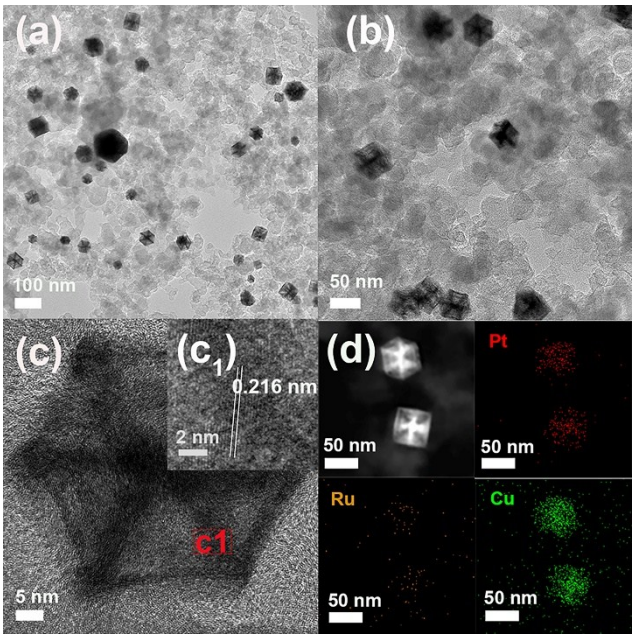

Fig. S4. (a) and (b) TEM, (c) HRTEM, (d) HAADF-STEM images and EDS 2D element mappings of PtRuCu NFs-HAc.

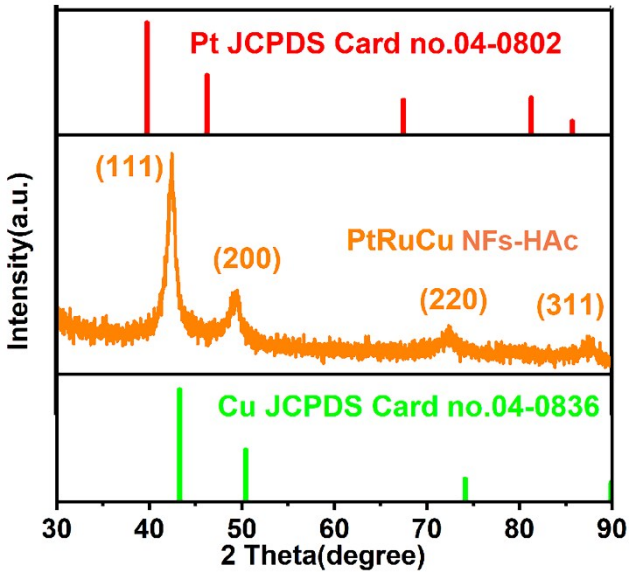

Fig. S5. XRD pattern of PtRuCu NFs-HAc.

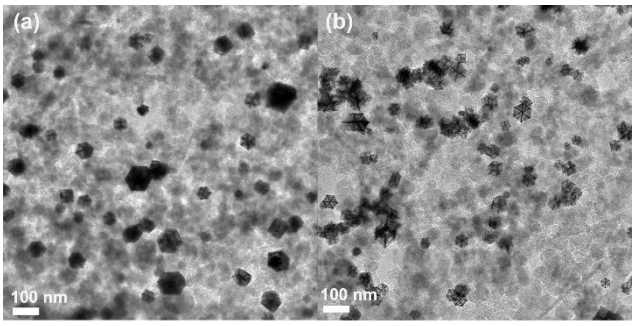

Fig. S6. TEM images of (a) PtRuCu NFs-HAc and (b) PtRuCu NFs.

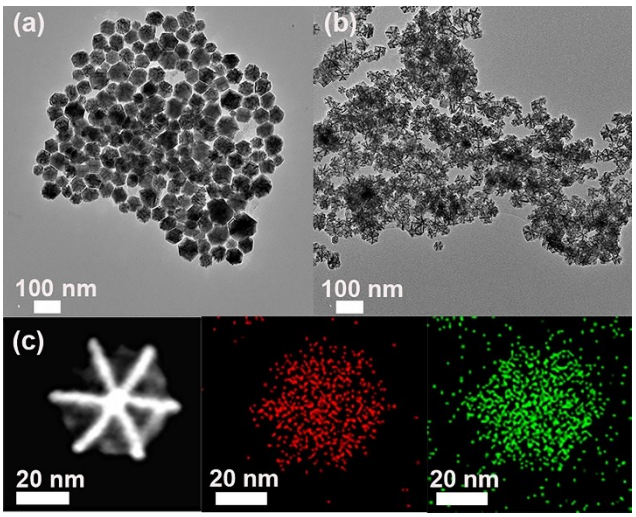

Fig. S7. (a) TEM image of PtCu NPs. (b) TEM image of PtCu NFs. (c) HAADF-STEM image and EDS 2D element mappings of PtCu NFs.

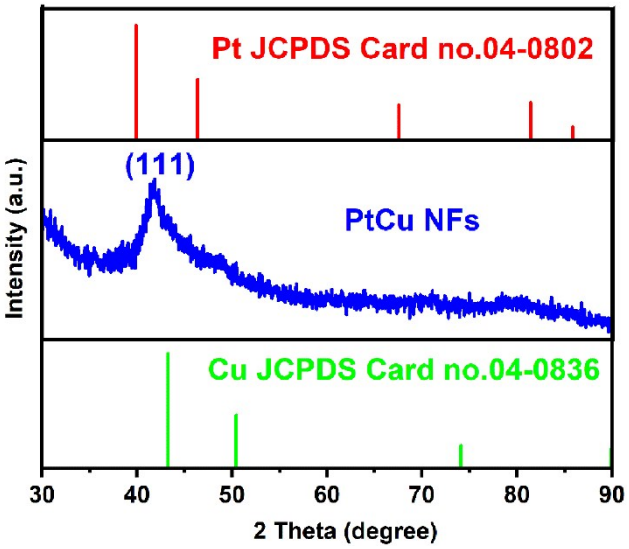

Fig. S8. XRD pattern of PtCu NFs.

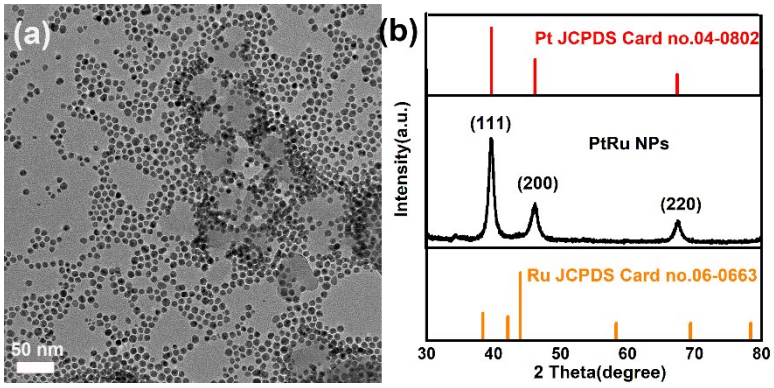

Fig. S9. (a) TEM image and (b) XRD pattern of PtRu NPs.

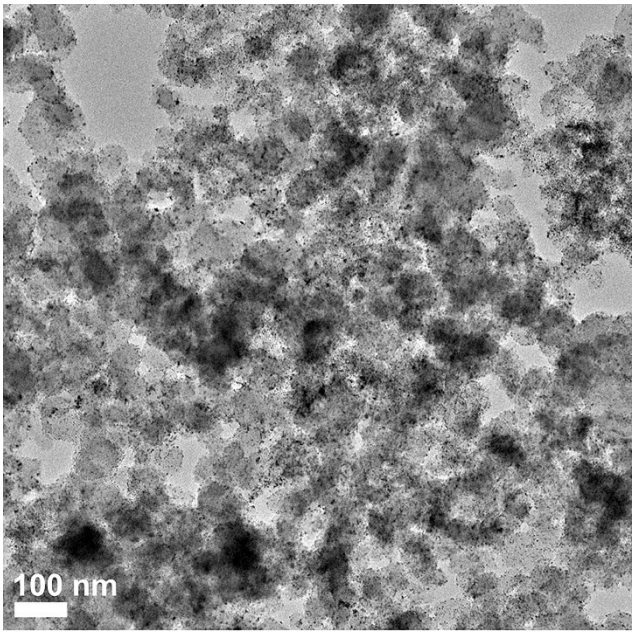

Fig. S10. TEM image of commercial Pt/C.

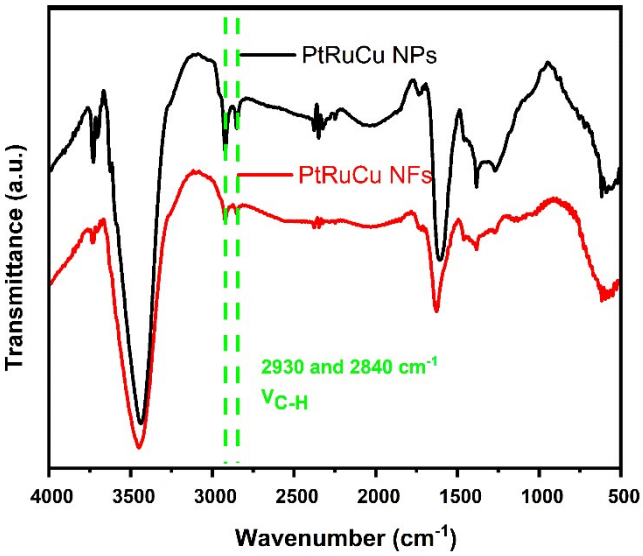

Fig. S11. FTIR spectra of PtRuCu NFs and PtRuCu NPs.

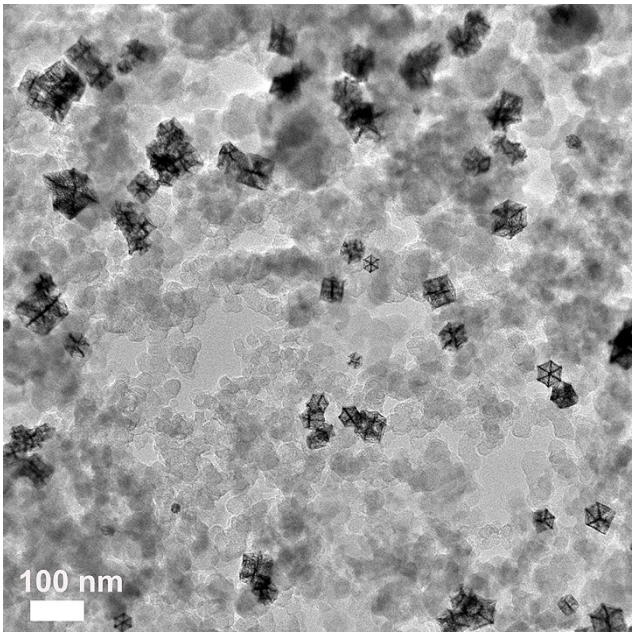

Fig. S12. TEM image of PtRuCu NFs-OAm/C.

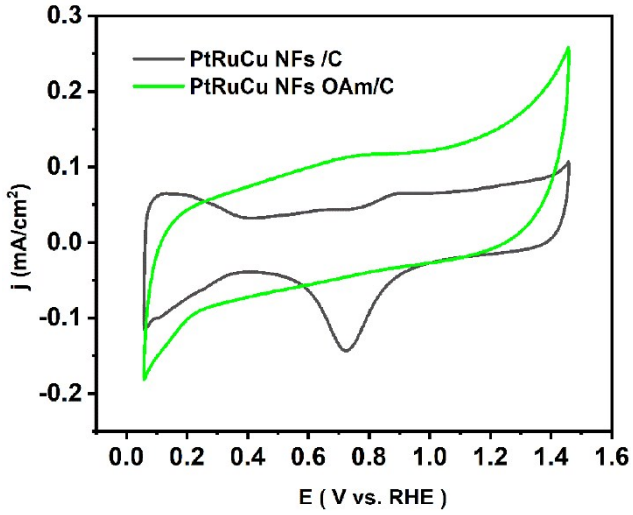

Fig. S13. CV curves in 0.1 M $HClO_4$ for PtRuCu NFs/C and PtRuCu NFs-OAm/C.

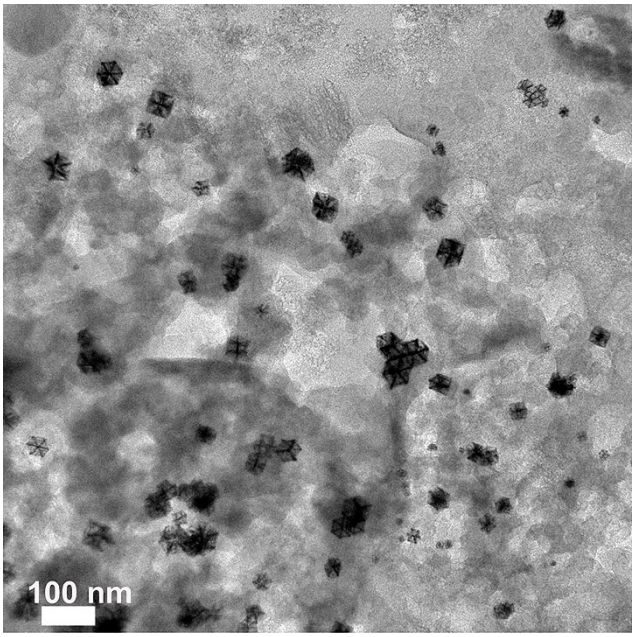

Fig. S14. TEM image of PtRuCu NPs after MOR test.

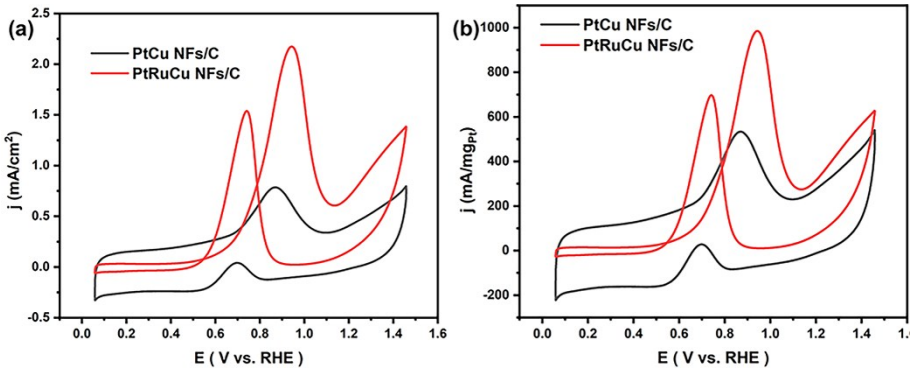

Fig. S15. Electrocatalytic activity of PtRuCu NFs/C and PtCu NFs/C. (a) specific activity and (b) mass activity in 0.1 M $HClO_4$ and 1 M CH_3OH solution.

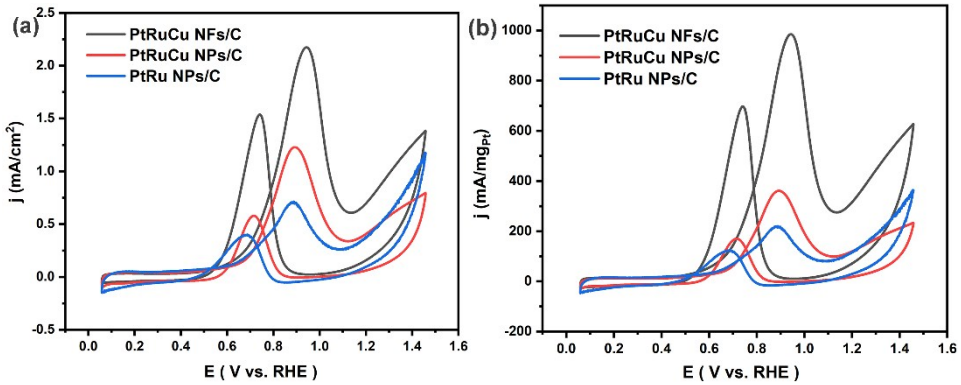

Fig. S16. Electrocatalytic activity of PtRuCu NFs/C, PtRuCu NPs/C and PtRu NPs/C. (a) specific activity and (b) mass activity in 0.1 M $HClO_4$ and 1 M CH_3OH solution

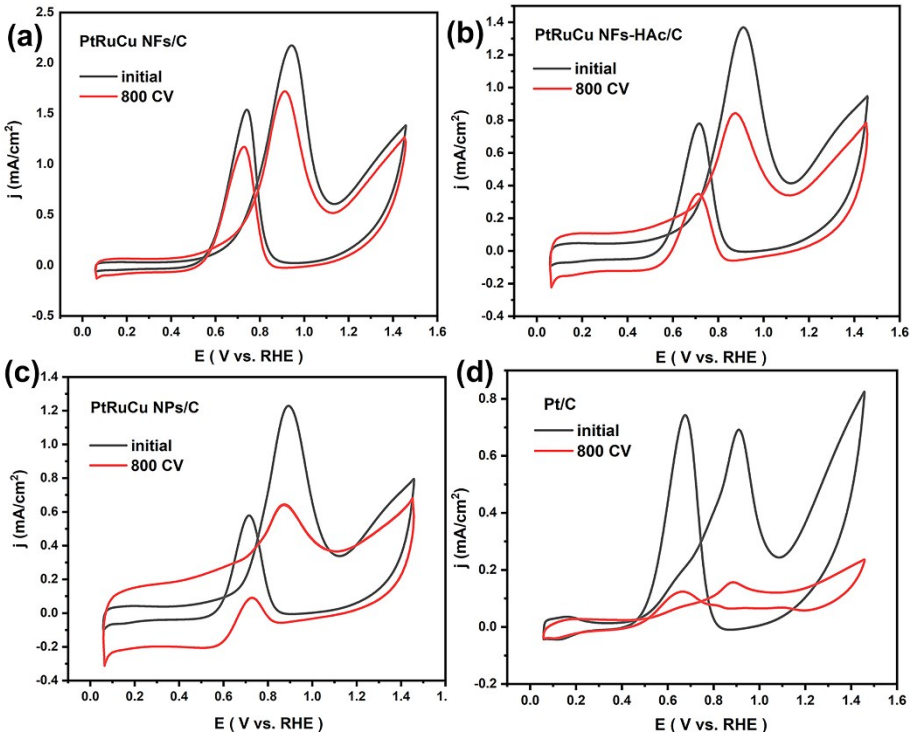

Fig. S17. MOR performance of (a) PtRuCu NFs/C, (b) PtRuCu NFs-HAc/C, (c) PtRuCu NPs/C and (d) Pt/C after 0 and 800 CV cycles.

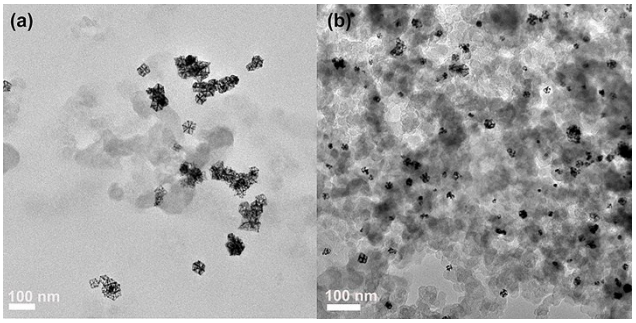

Fig. S18. TEM images of (a) PtRuCu NFs/C and (b) PtRuCu NFs-HAc/C after 800

CV cycles.

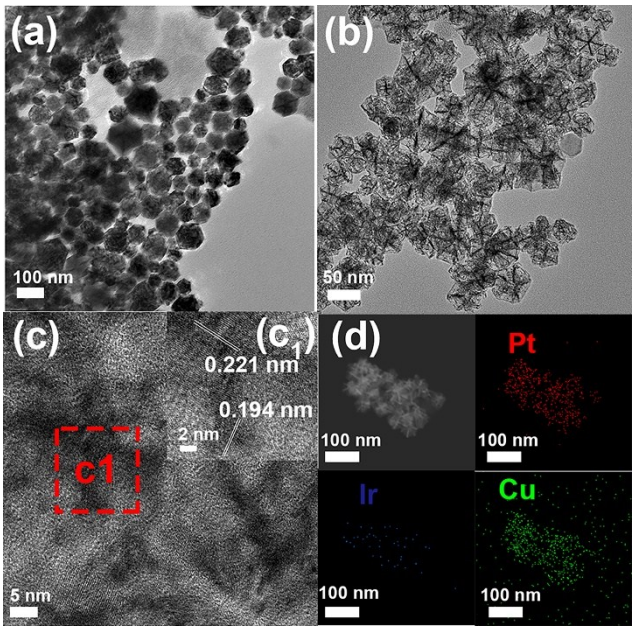

Fig. S19. (a) TEM image of PtIrCu NPs. (b)TEM, (c) HRTEM, (d) HAADF-STEM images and EDS 2D element mappings of PtIrCu NFs.

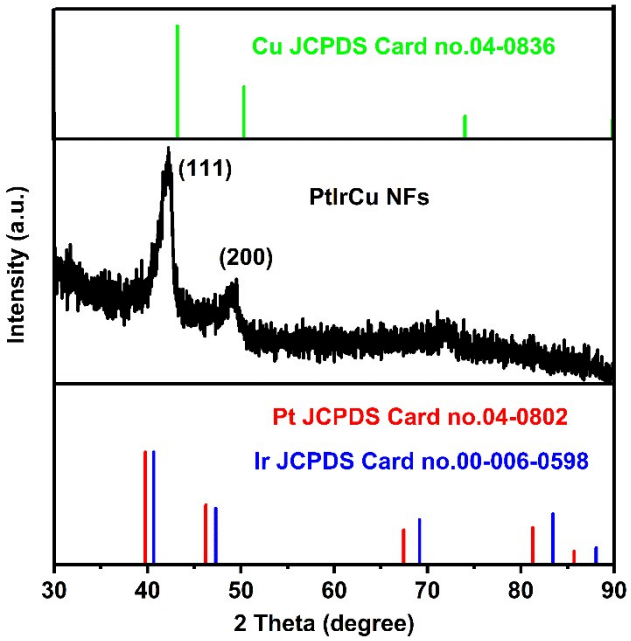

Fig. S20. XRD pattern of PtIrCu NFs.

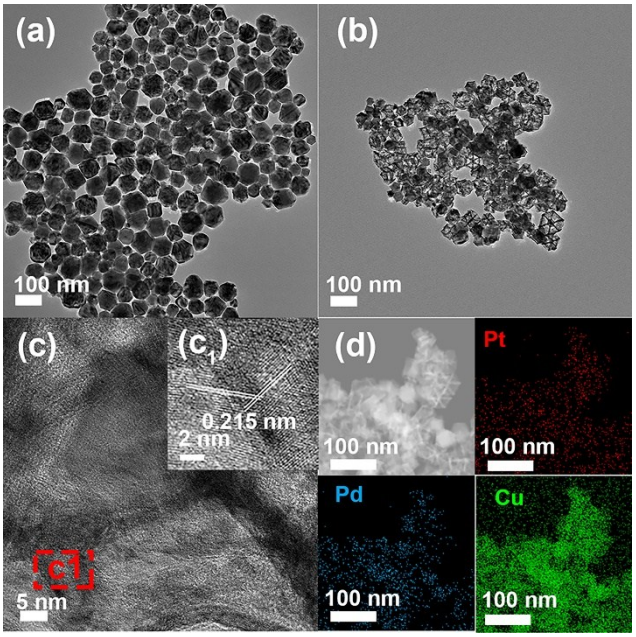

Fig. S21. (a) TEM image of PtPdCu NPs. (b)TEM, (c) HRTEM, (d) HAADF-STEM images and EDS 2D element mappings of PtPdCu NFs.

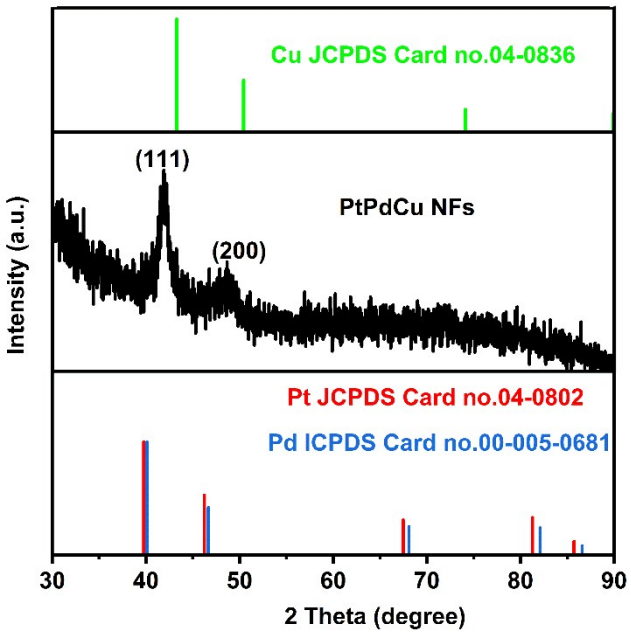

Fig. S22. XRD pattern of PtIrCu NFs.