**Fig. S1** SEM image of the mPtRu-NF.

**Fig. S2** SEM image of the mPtRu-NF.
**Fig. S3** The particle size distribution histogram of PtRu nanoparticles.

**Fig. S4** (a) SEM image and (b, c and d) elemental mapping images of the mPtRu-NF.
Fig. S5 TEM-EDX image of the mPtRu-NF.

<table>
<thead>
<tr>
<th>Element</th>
<th>Mass ratio %</th>
<th>Atomic ratio %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ru</td>
<td>25.58</td>
<td>39.89</td>
</tr>
<tr>
<td>Pt</td>
<td>74.42</td>
<td>60.11</td>
</tr>
</tbody>
</table>

Fig. S6 SEM images of the top-surface and cross-section views of the PtRu-NF prepared by replacing F127 with (a, d) Brij 58, (b, e) PVP, and (c, f) without surfactants, respectively, under the typical conditions used for the typical synthesis.
**Fig. S7** SEM images of the top-surface and cross-section views of the samples prepared under the typical conditions with (a, d) 0 μL, (b, e) 5 μL and (c, f) 125 μL HCl (6 M), respectively.

**Fig. S8** SEM images of the top-surface and cross-section views of the samples prepared by replacing HCl with (a, c) HNO₃ and (b, d) H₂SO₄, respectively, under the typical conditions used for the typical synthesis.
**Fig. S9** SEM images of the top-surface and cross-section views of the samples prepared under the typical conditions for (a, d) 3 h, (b, e) 6 h and (c, f) 24 h, respectively.

**Fig. S10** SEM images of the top-surface and cross-section views of the samples prepared with different amounts of the metallic precursors. The added amounts of metallic precursors, K$_2$PtCl$_4$ and RuCl$_3$ are (a, d) 3.0 mL and 0 mL (Pt-NF), (b, e) 2.5 mL and 0.5 mL (Pt$_3$Ru-NF), (c, f) 0.5 mL and 2.5 mL (PtRu$_5$-NF), respectively.
Fig. S11 OER polarization curves. The LSVs for OER were recorded in a 1 M KOH solution at a sweep rate of 5 mV s$^{-1}$.

Fig. S12 Tafel slopes of OER for the different samples.
Fig. S13 OER polarization curves before and after durability test for the mPtRu-NF.

Fig. S14 Chronoamperometric measurements of the samples tested at 1.5 V.
Fig. S15 Multicurrent process of mPtRu-NF. The current density started at 4 mA cm\(^{-2}\) and ended at 40 mA cm\(^{-2}\), using an increment of 4 mA cm\(^{-2}\) per 500 s without iR correction.

Fig. S16 ORR polarization curves of the different samples. The LSVs for ORR were recorded in an O\(_2\)-saturated 1 M KOH solution at a sweep rate of 5 mV s\(^{-1}\) with a rotation rate of 1600 rpm.
Fig. S17 The comparisons of $E_{\text{onset}}$ and $E_{1/2}$ for the different samples.

Fig. S18 The comparison of $j_k$ at 0.9 V for the different samples.
**Fig. S19** The CV curves of mPtRu and Pt/C in 0.5 M H₂SO₄ solution at a scan rate of 50 mV s⁻¹.

**Fig. S20** Tafel slopes of ORR for the different samples.
Fig. S21 (a) ORR polarization curves of the mPtRu with different RDE rotation rates. (b) The electron transfer numbers at different potentials. The LSVs were recorded in an O2-saturated 1 M KOH solution at a sweep rate of 5 mV s⁻¹.

Fig. S22 ORR polarization curves before and after durability test for the mPtRu.
Fig. S23 Chronoamperometric measurements of the samples tested at 0.9 V.