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**Base-free aerobic oxidation of 5-hydroxymethylfurfural  
to 2,5-furandicarboxylic acid over Pt/C catalysts synthesized by  
pulse alternating current technique**

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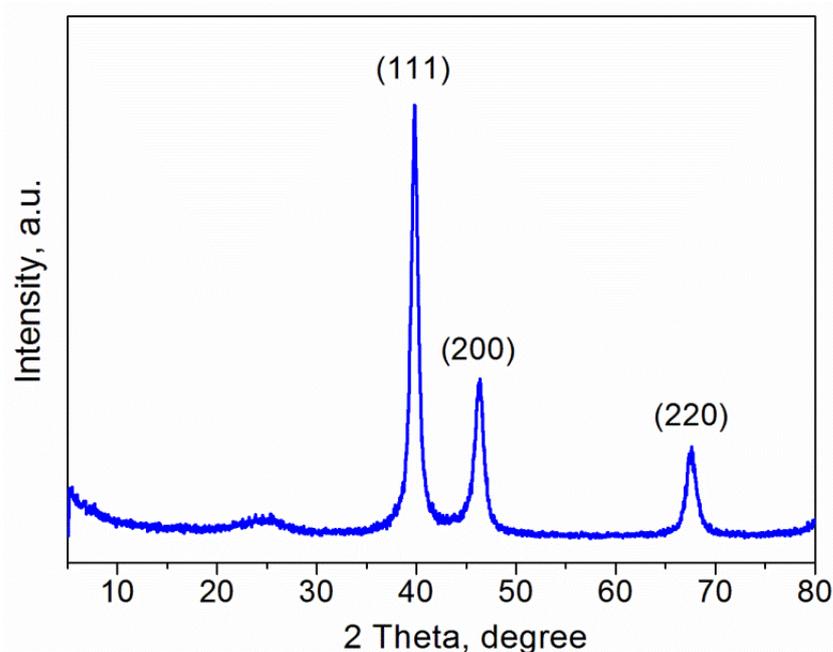
**Contents**

1. Structural characterization of Pt/C catalysts .....	S2
2. NMR spectra of 2,5-furandicarboxylic acid <b>2</b> .....	S3
3. Kinetics for the oxidation of 5-hydroxyfurfural <b>1</b> into <b>2</b> .....	S5
4. References .....	S5

## 1. Structural characterization of Pt/C catalysts

### 1.1 X-ray diffraction analysis

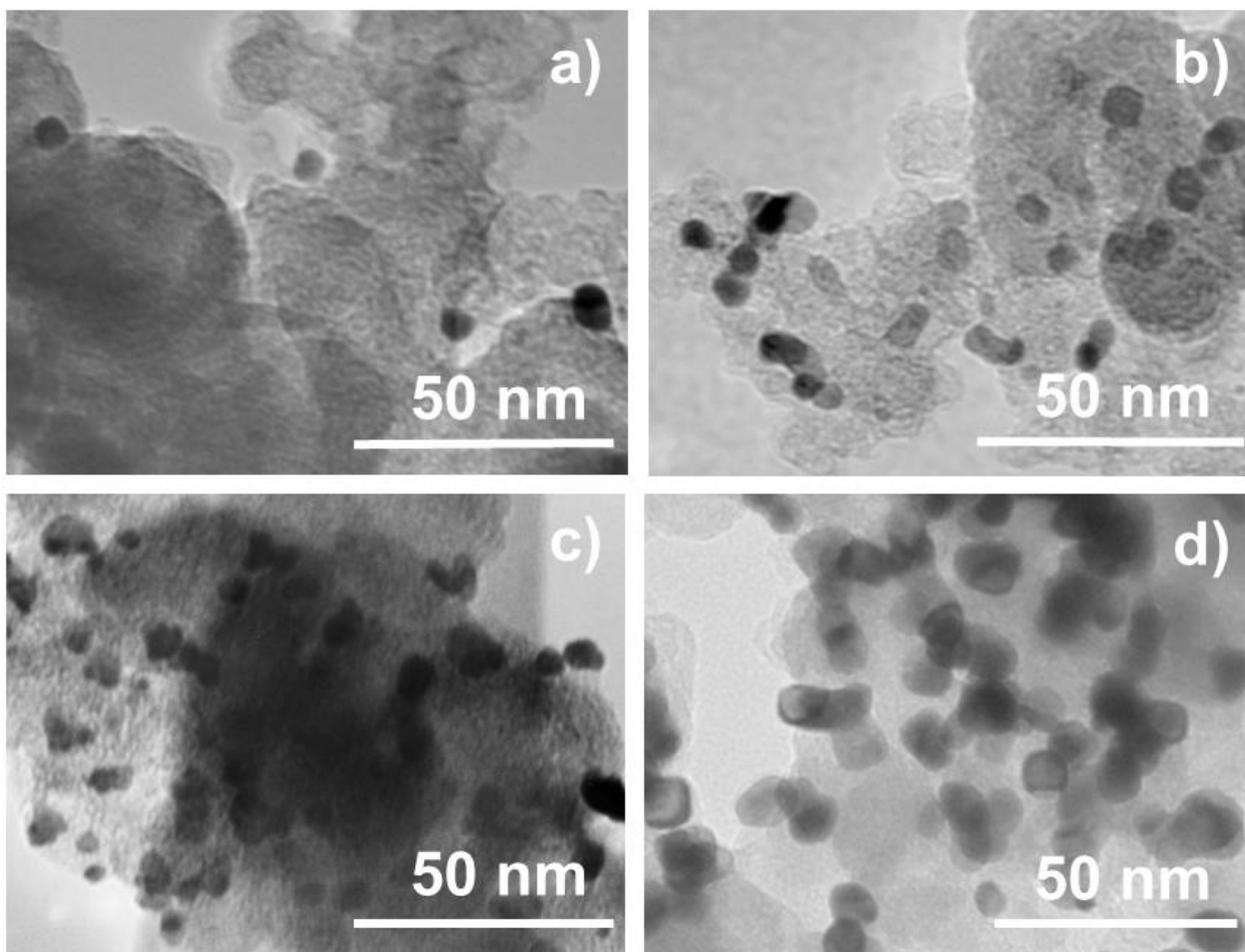
The X-ray diffraction (XRD) pattern of the Pt/C-30 catalyst synthesized via the electrochemical dispersion method is shown in Figure S1. Three well-defined diffraction peaks at  $39.7^\circ$ ,  $46.3^\circ$  and  $67.5^\circ$  are assigned to the (111), (200) and (220) crystal planes, respectively, of the Pt face-centered cubic structure [space group: Fm3m (no. 225)]. The particle size along the [111] ( $D_{111}$ ) calculated from the Scherrer equation is  $9 \pm 1$  nm [S1].



**Figure S1** XRD pattern of Pt/C-30 catalyst synthesized *via* electrochemical dispersion technique.

### 1.2 Transmission electron microscopy

Target-oriented approach was utilized for the optimization of the analytic measurements [S2]. Before measurements the samples were mounted on a 3 mm copper grid and fixed in a grid holder. Samples morphology was studied using Hitachi transmission electron microscope (TEM). Images were acquired in bright-field TEM mode at 100 kV accelerating voltage. TEM-images of Pt/C catalysts with different Pt loading obtained by the electrochemical dispersion method are presented in Figure S2. TEM study of the catalyst after synthesis revealed that the average Pt particle size slightly increases from 8-10 nm (for fresh catalyst) to 10-13 nm (for catalyst after synthesis), Figures S2c and S2d, respectively.

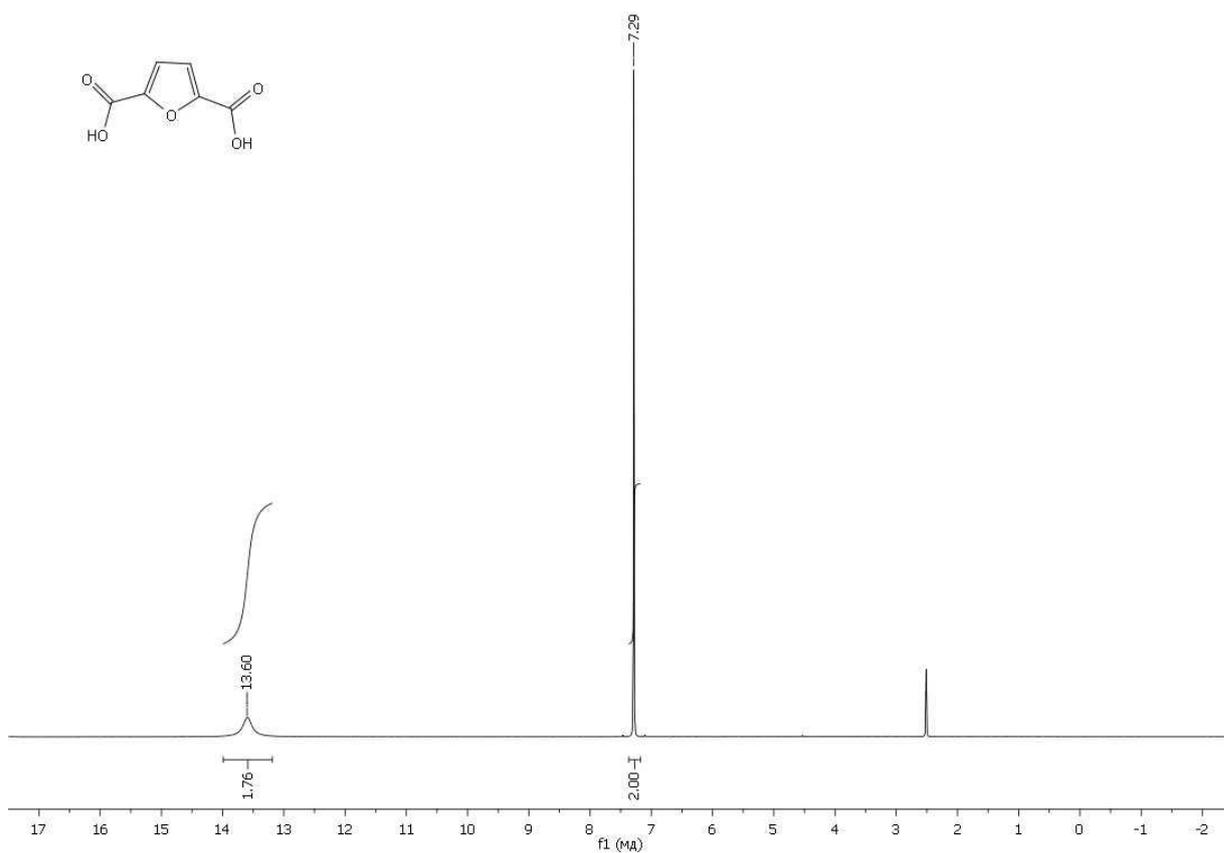


**Figure S2** TEM-images of Pt/C catalysts with different Pt loading: a) 5%; b) 15%; c, d) 30%; before (a-c) and after (d) base-free aerobic oxidation of HMF to FDCA at 0.25 MPa.

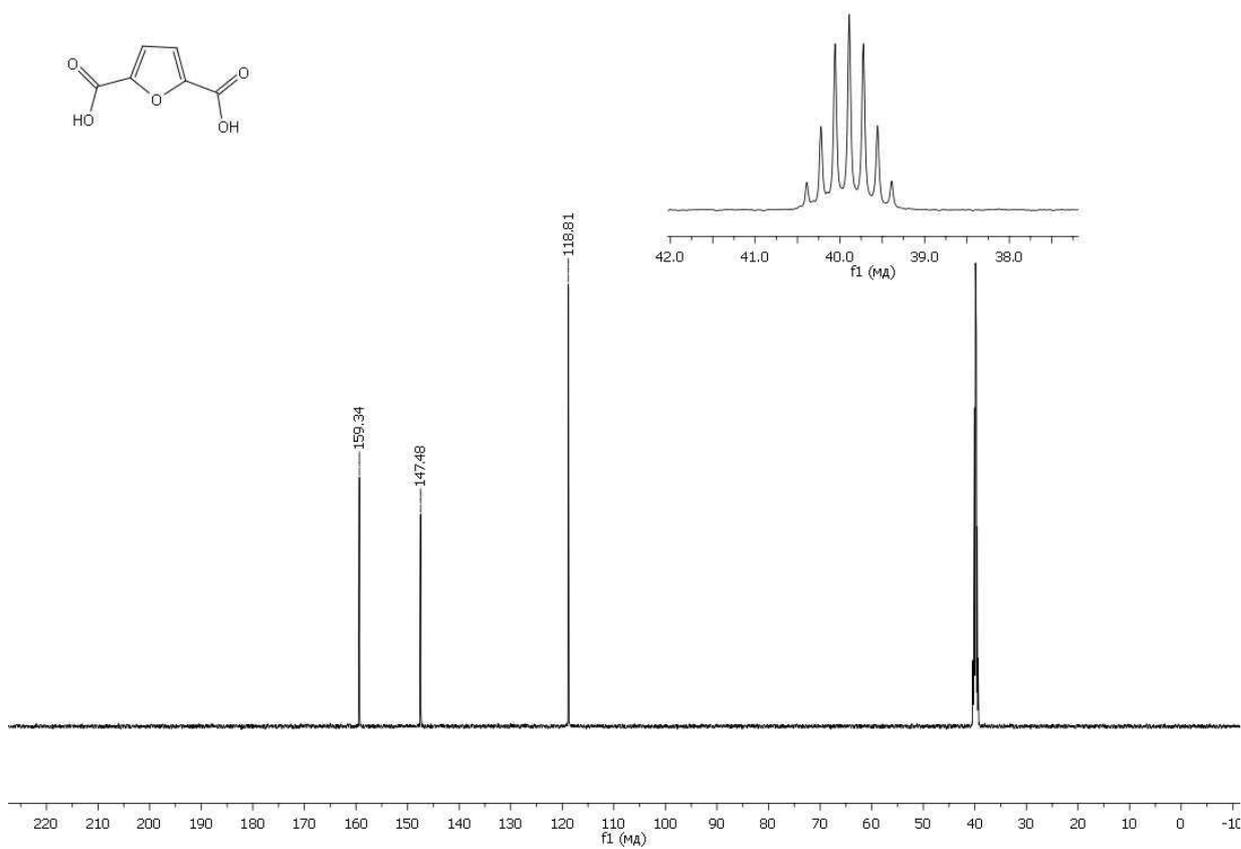
## 2. NMR spectra of 2,5-furandicarboxylic acid **2** obtained by the base-free aerobic oxidation of 5-hydroxymethylfurfural **1**

$^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ ):  $\delta$ , ppm: 7.29 (s, 2H, 2CH); 13.60 (s, 2H, 2COOH).

$^{13}\text{C}$  NMR ( $\text{DMSO-}d_6$ ),  $\delta$ , ppm: 118.8, 147.5, 159.3.

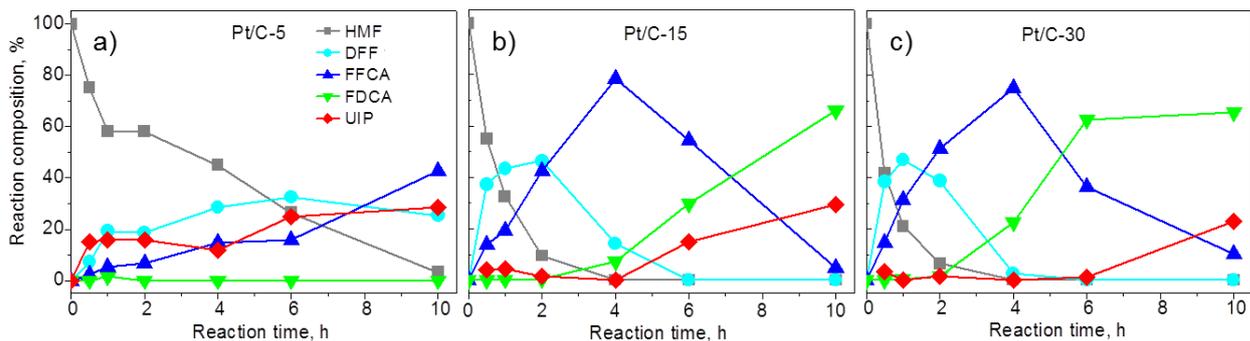


**Figure S3** <sup>1</sup>H NMR spectrum of **2** (purity  $\geq 99\%$ ).



**Figure S4** <sup>13</sup>C NMR spectrum of **2**.

### 3. Kinetics for the oxidation of 5-hydroxyfurfural 1 into 2



**Figure S5** Kinetic curves for the oxidation of **1** at 105 °C and 0.25 MPa: a) Pt/C-5, b) Pt/C-15, c) Pt/C-30. HMF denotes compound **1**, DFF – **3**, FFCA – **4**, FDCA – **2**, UIP denotes unidentified products, including humins.

#### References

- [S1] I. Leontyev, A. Kuriganova, Yu. Kudryavtsev, B. Dkhil and N. Smirnova, *Appl. Catal., A*, 2012, **431** (Supplement C), 120.
- [S2] V.V. Kachala, L.L. Khemchyan, A.S. Kashin, N.V. Orlov, A.A. Grachev, S.S. Zaleskiy and V.P. Ananikov, *Russ. Chem. Rev.*, 2013, **82**, 648.