Selectivity regulation of Au/titanate by biochar modification for selective oxidation of benzyl alcohol

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Section 1. SEM images

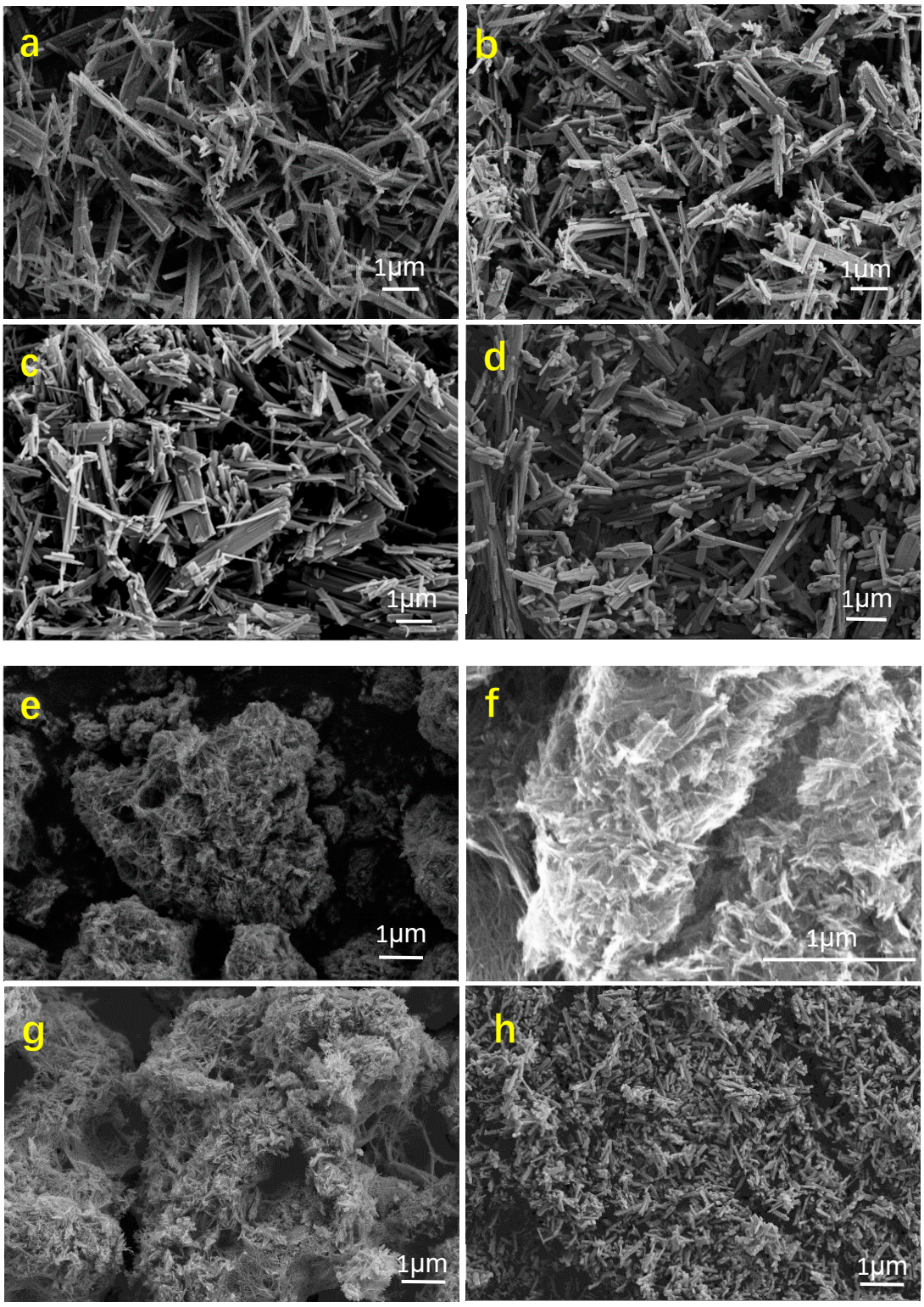

Fig. S1 SEM images of **(a)** Au/NaTINT$_S$, **(b)** Au/NaTINT$_S$-400Ar, **(c)** Au/NaTiNT$_S$-400Ar-400Air, **(d)** Au/NaTiNT$_S$-400Ar -800Air, **(e)** Au/BC$_{0.25}$@NaTiNT$_S$, **(f)** Au/BC$_{0.25}$@NaTiNT$_S$-400Ar, **(g)** Au/BC$_{0.25}$@NaTiNT$_S$-400Ar-400Air, **(h)** Au/BC$_{0.25}$@NaTiNT$_S$-400Ar-800Air.

Section 2. TEM images

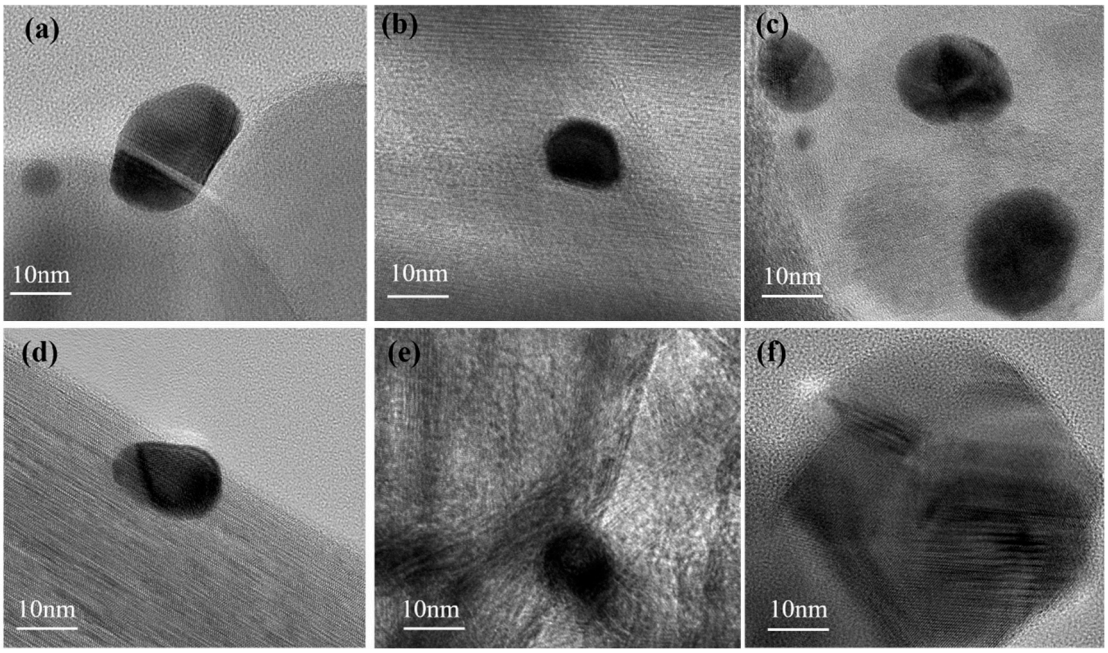

Fig. S2 TEM (a)Au/TiO_2-400Ar-400Air,(b) Au/NaTiNTs-400Ar-400Air,(c) Au/$BC_{0.10}$@NaTiNTs-400Ar-400Air, (d) Au/$BC_{0.25}$@NaTiNTs-400Ar-400Air, (e) Au/$BC_{0.50}$@NaTiNTs-400Ar-400Air , (f) Au/$BC_{1.00}$@NaTiNTs-400Ar -400Air

Section 3. XPS analysis of C1s and O1s over series of catalysts

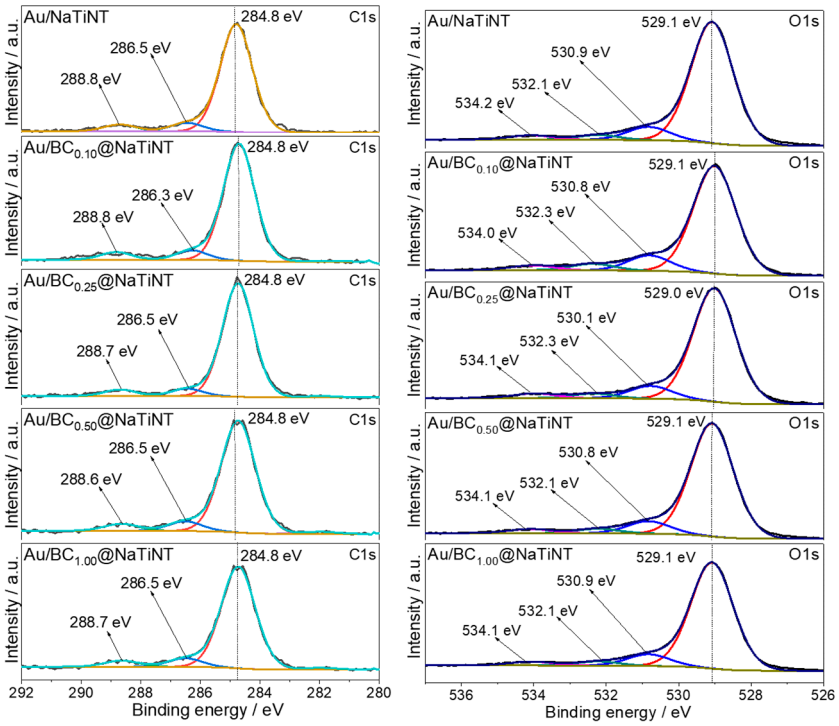

Fig. S3 XPS spectra of C1s (Left) and O1s (Right) over the catalysts of Au/NaTiNTs and series of Au/BC@NaTiNTs. Note: all the catalysts were calcined at 400°C in Ar first and then at 400°C in air.

Table S1. The proportion analysis as quantified by XPS spectra

Items		**C1s**			**O1s**			
		C-C	**C-O**	**O-C=O**	**Ti-O or Ti=O**	**O vacancy**	**O-H or ONa**	**O adsorbed**
Au/TiO_2	**BE / eV**	**284.8**	**286.5**	**288.6**	**529.0**	**530.6**	**531.8**	**--**
	Fraction %	91.5	5.4	3.1	86.6	11.6	1.8	--
Au/NaTiTN	**BE / eV**	**284.8**	**286.5**	**288.8**	**529.1**	**530.9**	**532.1**	**534.2**
	Fraction %	87.6	6.9	5.5	84.0	8.6	3.8	3.6
$Au/BC_{0.10}$@NaTiTN	**BE / eV**	**284.8**	**286.3**	**288.8**	**529.1**	**530.8**	**532.3**	**534.0**
	Fraction %	87.0	7.2	5.8	80.0	11.5	4.9	3.6
$Au/BC_{0.25}$@NaTiTN	**BE / eV**	**284.8**	**286.5**	**288.7**	**529.0**	**530.1**	**532.3**	**534.1**
	Fraction %	89.1	5.8	5.1	83.7	9.4	3.5	3.4
$Au/BC_{0.50}$@NaTiTN	**BE / eV**	**284.8**	**286.5**	**288.6**	**529.1**	**530.8**	**532.1**	**534.1**
	Fraction %	87.1	7.5	5.4	84.2	9.3	3.4	3.1
$Au/BC_{1.00}$@NaTiTN	**BE / eV**	**284.8**	**286.5**	**288.7**	**529.1**	**530.9**	**532.1**	**534.1**
	Fraction %	87.4	7.4	5.2	84.3	9.3	3.3	3.1

Section 4. Comparison of reaction rates based on ICP tests

The actual content of Au on the prepared catalysts were detected by ICP-OES (**Table s2**). The results showed that the actual loading of Au on the surface of most catalysts was generally lower than the theoretical value. Based on the real loading of gold, the reaction rate of benzyl alcohol and the production rate of benzaldehyde were calculated as shown below.

Table S2. The reaction rate of benzyl alcohol and the production rate of benzaldehyde over typical catalysts

	In air	Au/TiO_2 (0.64%)	$Au/NaTiNT_S$ (1.00%)	$Au/BC_{0.10}$ @$NaTiNT_S$ (0.90%)	$Au/BC_{0.25}$ @ $NaTiNT_S$ (0.96%)	$Au/BC_{0.50}$ @ $NaTiNT_S$ (0.86%)	$Au/BC_{1.00}$ @ $NaTiNT_S$ (0.56%)
Reaction rate / $mmol_{reactant}/(g_{Au}\cdot h)$	200℃	338.9	199.3	203.7	79.2	77.5	71.4
	400℃	330.0	195.3	185.9	166.7	253.3	213.1
	600℃	285.4	172.6	162.2	163.2	14.8	10.7
	800℃	357.3	70.7	131.9	168.1	33.3	89.3
Production rate / $mmol_{product}/(g_{Au}\cdot h)$	200℃	266.7	103.4	147.7	73.7	76.7	70.7
	400℃	245.5	114.0	124.6	93.2	235.1	192.9
	600℃	218.9	114.1	118.6	91.6	14.7	10.6
	800℃	260.8	49.1	71.6	133.6	33.0	88.9

[a] The nominal loading of gold was 1wt% and the real loading detected by ICP was given in the parentheses.

Reaction conditions: catalyst (100 mg), benzyl alcohol (4 mmol), toluene (20 ml), NaOH (0.4 mmol), reaction temperature oil bath 60°C, 6 h, air atmosphere. **Note**. All the catalysts were calcined in Ar first then were calcined in air.