

# Acetalization of alkyl alcohols with benzaldehyde with alkyl alcohols over cesium phosphomolybdovanate salts

MÁRCIO JOSÉ DA SILVA<sup>1\*</sup>, CLÁUDIO JUNIOR ANDRADE RIBEIRO<sup>2</sup>, AND ISADORA MERIGHI TORTELOTI<sup>1</sup>

<sup>1</sup>*Chemistry Department, Federal University of Viçosa, Viçosa, Minas Gerais, Brasil. zip-code: 36590-000*

<sup>2</sup>*Chemistry Department, Federal Institute of Education, Science and Technology of Minas Gerais, São João Evangelista, Minas Gerais, Brasil. zip-code: 39705-000*

## SUPPLEMENTAL MATERIAL

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**Figure S1.** Unsubstituted cesium phosphomolybdate (first), and containing 1(second), 2 (third), or 3 (fourth) vanadium atoms.



(a)



(b)

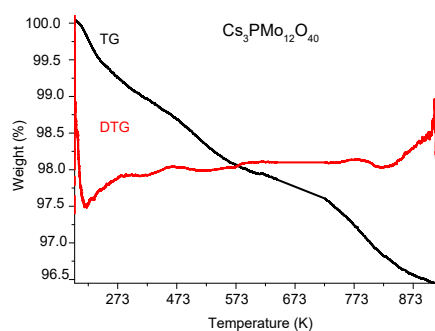


(c)

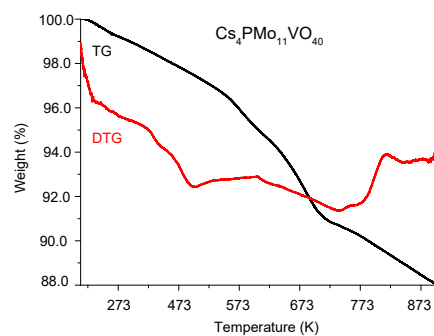


(d)

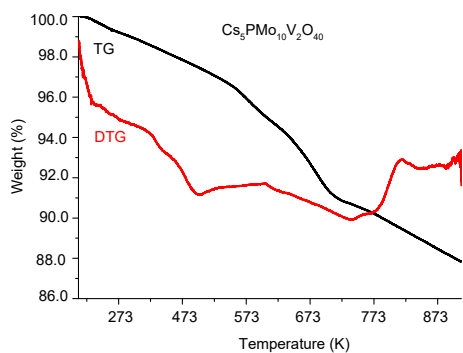
**Figure S2.** Comparison of unsubstituted cesium phosphomolybdate salt and acid (first) (a), and containing 1(second) (b), 2 (third) (c), or 3 (fourth) (d) vanadium atoms



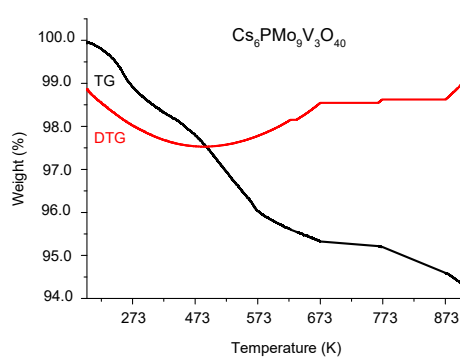
(a)



(b)

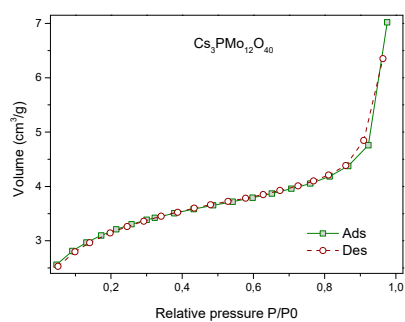


(c)

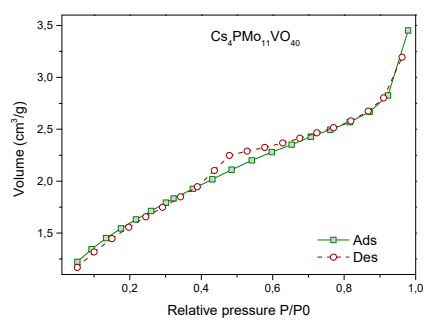


(d)

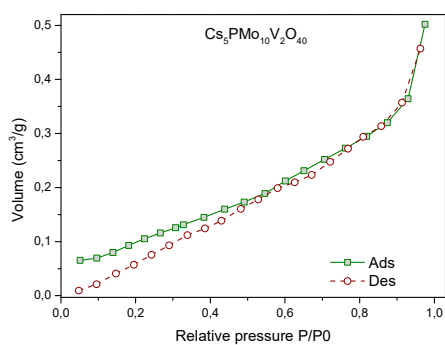
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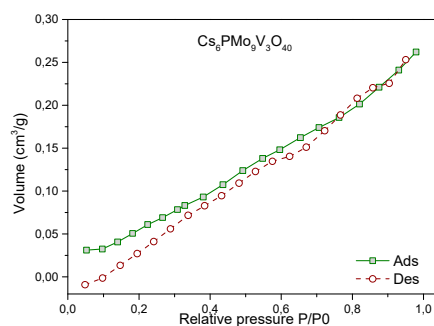
(a)



(b)

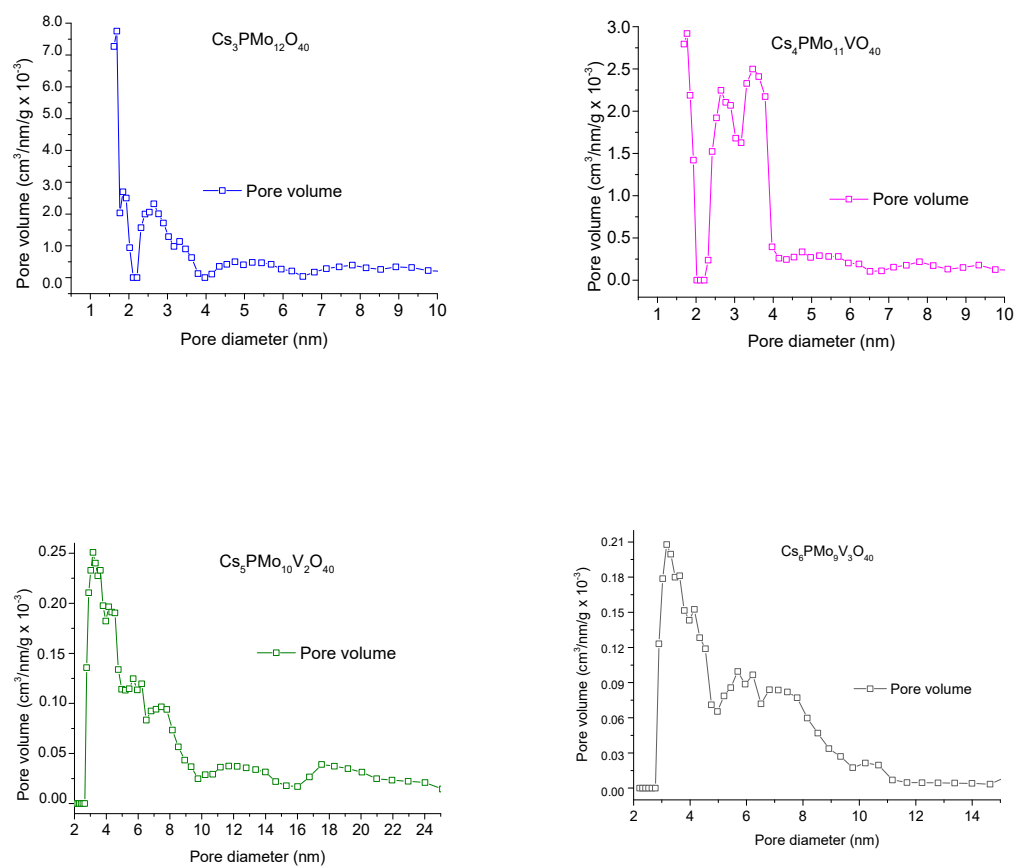


(c)



(d)

**Figure S4.** Isotherms of nitrogen desorption/ adsorption of unsubstituted and vanadium-substituted cesium phosphomolybdate salts



**Figure S5.** Diameter and volume of pores of unsubstituted and vanadium-substituted cesium phosphomolybdate salts

**Table S1.** Surface area, volume and diameter of pores phosphomolybdic acid and their unsubstituted and vanadium-substituted cesium salts

| Catalyst   | Surface area<br>(m <sup>2</sup> g <sup>-1</sup> ) | Pore volume<br>(cm <sup>3</sup> g <sup>-1</sup> ) x 10 <sup>-3</sup> | Pore diameter<br>(Å) |
|--|---|--|----------------------|
| H <sub>3</sub> PMo <sub>12</sub> O <sub>40</sub>                 |   |  |                      |
| Cs <sub>3</sub> PMo <sub>12</sub> O <sub>40</sub>                | 104.1   | 37.3   | 2.0                  |
| Cs <sub>4</sub> PMo <sub>11</sub> VO <sub>40</sub>               | 55.6  | 17.4   | 3.5                  |
| Cs <sub>5</sub> PMo <sub>10</sub> V <sub>2</sub> O <sub>40</sub> | 4.1   | 1.0  | 3.1                  |
| Cs <sub>6</sub> PMo <sub>9</sub> V <sub>3</sub> O <sub>40</sub>  | 2.8   | 0.5  | 3.1                  |

**Table S2.** Crystallite sizes of phosphomolybdic acid and their unsubstituted and vanadium-substituted cesium salts

| Catalyst   | Crystallite size<br>(nm) |
|--|--------------------------|
| H <sub>3</sub> PMo <sub>12</sub> O <sub>40</sub>                 | 6.95                     |
| Cs <sub>3</sub> PMo <sub>12</sub> O <sub>40</sub>                | 0.15                     |
| Cs <sub>4</sub> PMo <sub>11</sub> VO <sub>40</sub>               | 0.15                     |
| Cs <sub>5</sub> PMo <sub>10</sub> V <sub>2</sub> O <sub>40</sub> | 5.74                     |
| Cs <sub>6</sub> PMo <sub>9</sub> V <sub>3</sub> O <sub>40</sub>  | 0.14                     |