

# Pore structure and Humidity Controlling Characteristics of Mesoporous Silica Synthesized in Acid Medium

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**Abstract** The mesoporous silica material (SH), with controlled pore size has been synthesized using hexadecyltriethylammonium bromide (CTAB) as template under acidic condition at room temperature. Then SH has been modified by adding 1, 3, 5-trimethylbenzene (TMB) to SH+TMB. The microstructure of samples has been obtained by small angle X-ray scattering and high resolution transmission electron microscopy. The Brunauer-Emmett-Teller (BET) surface area of the products has been determined by means of nitrogen adsorption. Their moisture absorption and desorption have been investigated. The results show that the humidity controlling performances of SH+TMB are better than that of SH.

**Key words** mesoporous silica; moisture absorption and desorption; humidity controlling material

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## 1 Introduction

The humidity controlling material is a kind of new multifunction material which can adjust indoor moisture automatically through adsorbing and desorbing water from the air<sup>[1]</sup>. In this research, the hexadecyltriethylammonium bromide (CTAB) has been used as template under acidic condition at room temperature to produce the mesoporous silica material. Then it has been modified by adding 1, 3, 5-Trimethylbenzene (TMB)<sup>[2]</sup>.

## 2 Experiment

### 2.1 Preparation

The SH was obtained by the molar composition of the precursor mixture was 1 TEOS:0.12 CTAB:9 HCl:130 H<sub>2</sub>O. In order to modify SH, TMB was added to the solution with the molar ratio of TMB and CTAB is 2<sup>[3]</sup>.

### 2.2 Characterization

Small angle X-ray scattering (SAXS) of the samples was carried out by X-ray diffraction. High resolution transmission electron microscopy (HRTEM) was used to observe a lattice image. The BET surface area of the products was determined by means of nitrogen adsorption. The water vapor adsorption-desorption isotherms were surveyed along with time.

## 3 Results and discussion

### 3.1 Structure characterization

Ordered structure of mesoporous materials are characterized by SAXS. As shown in Fig 1, SH and SH+TMB both have very intense diffraction peaks. After adding TMB, diffraction peak of SH excurses to low angle, it means that SH+TMB has larger interplanar distance and aperture than SH. The insert TEM photograph of SH reveals a well parallel channel corresponding to the side-on view of the tunnel shaped pores. The diameter of the regular array of channels is approximately 3.4 nm.

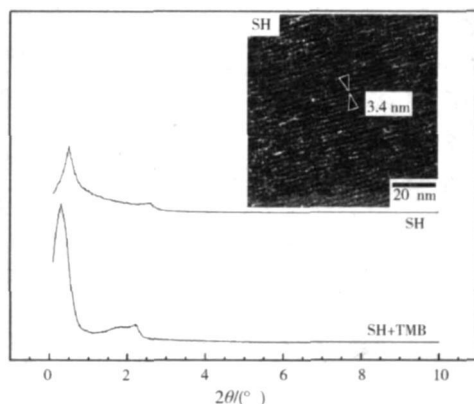


Fig 1 SAXS of SH and SH+TMB  
(The insert shows TEM Photograph of SH)

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3.2 Pore size distribution

Tab 1 and Fig 2 describe that the pore size diameter of SH and SH+TMB are in the region of 2~7 nm. Compared with SH, the average aperture, surface area and total pores volume of SH+TMB are bigger, however the pore size distribution is narrower.

| Tab 1 Average aperture, surface area, pore volume of SH and SH+TMB |                                 |                                                   |                                                        |
|--------------------------------------------------------------------|---------------------------------|---------------------------------------------------|--------------------------------------------------------|
| Samples                                                            | Average aperture / $\text{\AA}$ | Surface area / $(\text{m}^2 \cdot \text{g}^{-1})$ | Total Pores volume / $(\text{mL} \cdot \text{g}^{-1})$ |
| SH                                                                 | 3.931E+01                       | 1.033E+03                                         | 1.015E+00                                              |
| SH+TMB                                                             | 4.925E+01                       | 1.156E+03                                         | 1.423E+00                                              |

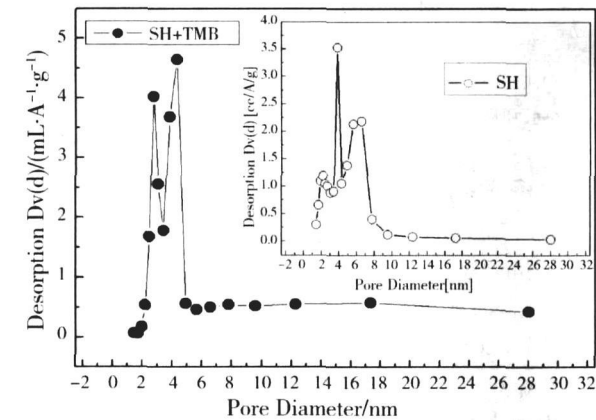


Fig 2 Pore size distribution of SH and SH+TMB

3.3 Humidity controlling characteristics

The moisture absorption and desorption of SH and SH+TMB are shown in Fig 3. Because their humidity controlling abilities mainly depend on the effect of capillary vessel condense and the surface adsorption<sup>[4]</sup>. As the curves show that the SH has the excellent humidity controlling characteristics, and through adding the TMB, the humidifying treatment performance has been enhanced.

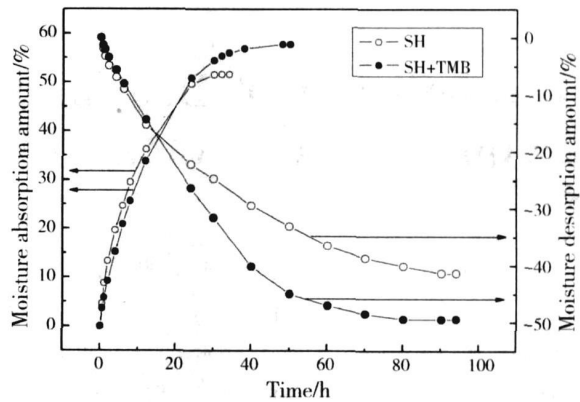


Fig 3 Moisture absorption and desorption amount change along with time of SH and SH+TMB

4 Conclusions

- 1) The SH which has been synthesized by using CTAB as template under acidic condition at room temperature has a well parallel channel corresponding to the view of the tunnel shaped pores. And it has the high humidity controlling function.
- 2) Through adding TMB, it can increase the average aperture, surface area, and total pores volume, therefore the humidifying treatment performance has been enhanced.

References

[ 1 ] RAN M Y. Review of research and application of air humidity controlling materials in Japan [ J ]. Materials review, 2002, 11: 42—44.  
[ 2 ] BRANTON P J, DOUGHERTY J, LOCKHART G, et al. Characterization of porous solids IV [ J ]. Royal Society of Chemistry, Cambridge, 1997, 668.  
[ 3 ] GAO X H, HEDDW, WANG X F, et al. Effect of templates on pore structure and performance of MCM—41 molecular sieves [ J ]. Petroleum process and petrochemicals, 1998, 29: 57—61.  
[ 4 ] GRACE S J, XIN K SW. Adsorption, surface area and hole proportion [ M ]. Beijing: Chemical Industry Press, 1982, 38.

酸性条件下合成介孔氧化硅的孔结构及其调湿性能

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摘 要：以十六烷基三甲基溴化铵作模板剂，采用酸性常温法制备介孔氧化硅材料 SH，通过添加 TMB 扩孔剂对其进行改性得到 SH+TMB，分别测试其吸湿、放湿性能，并采用小角度 XRD、TEM、BET 等测试手段研究其孔结构、比表面积和孔径分布等，分析微观形貌与其调湿性能之间的关系。结果表明：酸性条件下合成的介孔氧化硅 SH 有着很好的吸湿放湿性能，并且添加 TMB 后其湿度调节能力增大。

关键词：介孔氧化硅；吸湿放湿；调湿材料

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