Carbide-Derived Carbons for Adsorptive Removal of VOCs from Air Streams

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**Background**

Papermaking industry produces volatile organic compounds (VOCs), which have highly controlled emissions. During the pulping and bleaching processes, methanol (MeOH) and formaldehyde (CH2O) are off-gassed. Increasing the VOC removal rate while decreasing removal cost is an advancement for the industry and the environment.

**Adsorptive Methods**

Carbide-derived carbons (CDCs) provide ideal adsorptive properties:
- Tunable pore size
- Narrow pore size distribution
- High surface area
- Chemical selectivity
- Chemical stability

Amorphous carbons display similar properties to CDCs but lack control over pore size and pore size distribution. This narrows the relevance and efficiency in VOC removal. CDCs are under increasing interest as a method to improve upon the performance of amorphous carbons.

While possessing many of the great properties of CDCs, metal-organic frameworks (MOFs) lack chemical stability, especially in the presence of water. This currently hinders the applicability of this otherwise useful adsorbent.

**Carbide-Derived Carbons**

- **TiC Precursor – Titanium and Carbon Matrix**
  - Chlorination 400°C-1200°C Time
  - TiCDC – Residual Metal
  - Chlorination 400°C-1200°C Add'l Time
  - TiCDC – Carbon Matrix

**Literature Results**

These TEM images show TiCDC at 5nm (left) and at 3µm (right). TiCDC matrix retains its original shape after the chlorination process.

Pore-size distribution for synthesized TiC reduced to TiCDC.

**Motivation**

Active site functionalization improves the affinity for MeOH and CH2O. This is achieved through selection of the metal carbide precursor. Possible carbides include:
- TiC
- VC
- MoC
- ZrC
- NbC

Targeted synthesis allows for residual metal ions within the carbon structure and the potential for surface functionalization. Etching conditions, including time and temperature, influence total residual metal content.

**Future Research**

Investigate the ideal conditions for TiCDC synthesis with the highest affinity for VOCs by focusing on:
- The effect of residual metal in the CDC matrix on adsorbance
- The effect of pore size and pore size distribution from precursor synthesis and chlorination temperature on adsorbance

**References**


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