Synthesis of porous boron nitride as an adsorbent for bisphenol A

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Introduction

The efficient removal of organic pollutants from waste water is important to minimize their detrimental effects on the environment. Advanced adsorbent materials need to be developed to address this problem. Boron nitride (BN) has long been known for its high thermal and chemical stability. It is only recently that porous boron nitride is attracting attention as an adsorbent for pollutants [1,2]. The formation of BN-layers occurs which consist of a hexagonal plane with boron and nitrogen atoms linked by sp^2 hybridized orbitals. This hexagonal BN is able to interact with organic pollutants via pi-pi interaction in a similar way as graphene layers interact with aromatic organic compounds. The effect of ceramization temperature on the material characteristics of porous BN was investigated as well as their capability to remove BPA from water.

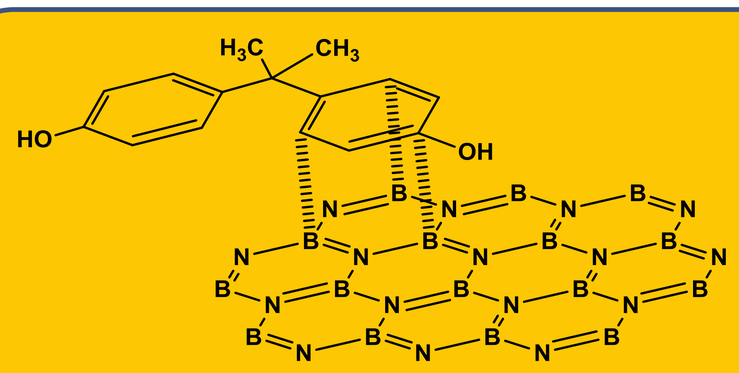


Figure 1: Adsorption of BPA onto hexagonal BN

Synthesis

Step 1: Precursor formation

$2H_3BO_3 + C_3N_6H_6$ (Boric acid, melamine) —90°C, H_2O, 12h→ $C_3N_6H_6 \times 2H_3BO_3$ (Melamine-diborate complex)

Step 2: Ceramization

$C_3N_6H_6 \times 2H_3BO_3$ —high T, N_2-atm→ $2BN$ (Porous boron nitride) $+ 3H_2O + 2CO + 3NH_3 + N_2$ (Reaction gasses introduce porosity)

Variation in ceramization temperature: **1400°C**, **1500°C**, **1600°C**, **1700°C**

Characterization

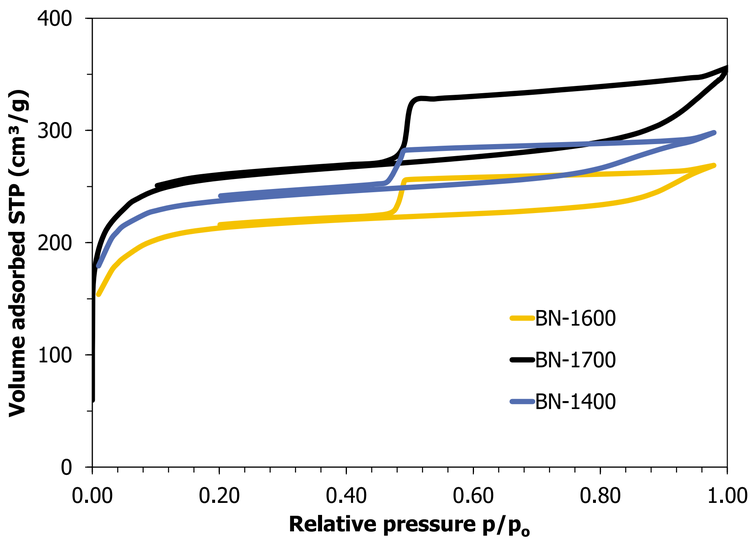


Figure 3: N_2-sorption measurements of BN-1400, BN-1600 and BN-1700

- Type IV isotherm with H3 hysteresis
- Micro- and mesoporous material
- Interconnected pores or ink-bottle pores
- Disordered pores
- BN-1700 has highest S_{BET} and V_P

Material	S_{BET} (m^2/g)	Vp (cm^3/g)	Pore size
BN-1400	855	0.45	0-30 nm
BN-1600	815	0.40	0-40 nm
BN-1700	959	0.55	0-40 nm

- Typical diffraction peaks at 26° and 43° for hexagonal BN
- Broad peaks = turbostratic BN
- Sharp peak = hexagonal
- Higher temperature increases hexagonal phase in BN
- BN-1700 shows sharp peak at 26° indicating more h-BN phase

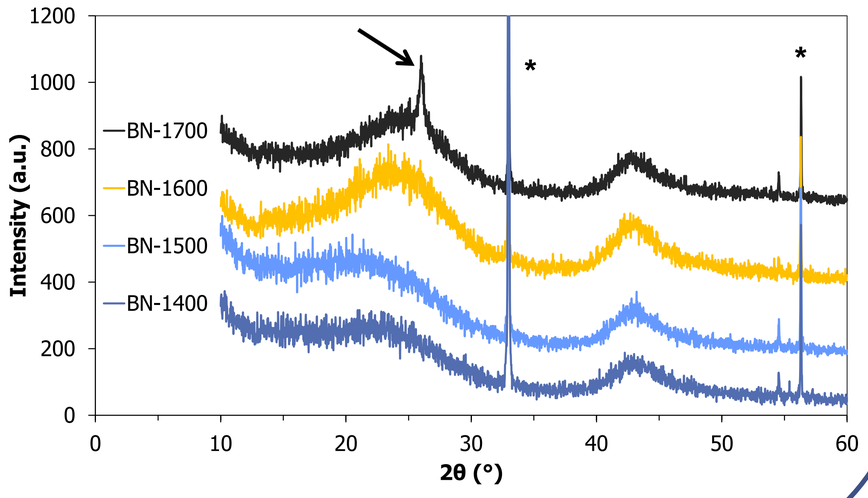


Figure 4: XRD diffractogram of the BN-material, peaks with * from Si-holder

Adsorption of BPA

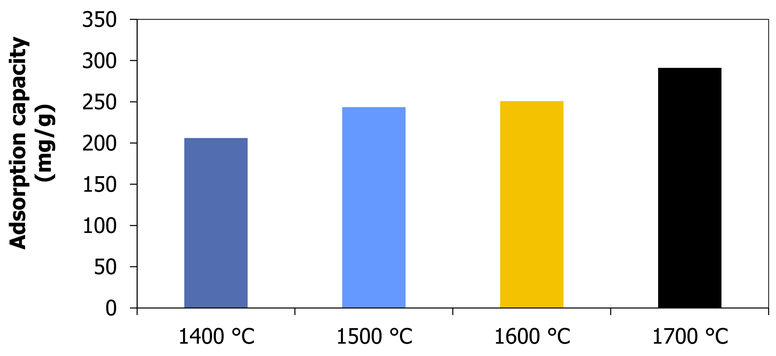
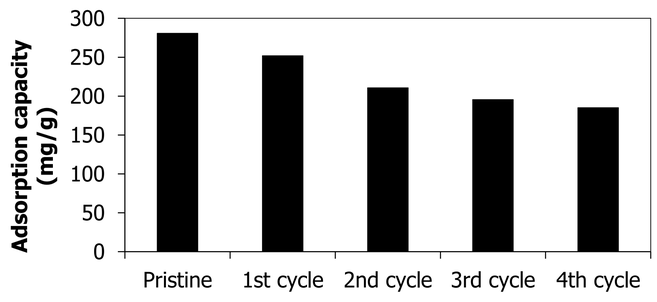


Figure 5: Adsorption capacities of BPA onto BN-materials ceramized at different temperatures.

- Increased ceramization temperature increases the adsorption capacity for BPA
- Higher specific area increases the adsorption of BPA
- Hexagonal phase of BN is important factor too

Reusability tests



- Reusability of BN-1700 for BPA adsorption
- BPA removed at 400°C in air for 2h
- Pristine: adsorption capacity of 281 mg/g
- Decrease with every cycle
- After 4 cycles still an adsorption capacity of 186 mg/g

Figure 6: Adsorption capacities of BPA after regeneration of BN-1700.

Conclusions

- ✓ Micro- & mesoporous BN with high S_{BET} synthesized.
- ✓ S_{BET} increased and hexagonal phase enhanced at higher ceramization temperature
- ✓ The higher S_{BET} and more pronounced hexagonal structure increase the adsorption capacity of BPA
- ✓ Regeneration decreases the adsorption capacity with every cycle, but remains high (186 mg/g) after 4 cycles

References

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Acknowledgments

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