BAB V
KESIMPULAN DAN SARAN

5.1 Kesimpulan

Kegiatan penelitian yang dilakukan menghasilkan beberapa kesimpulan. Adapun kesimpulan yang dihasilkan adalah sebagai berikut.

1. Seiring dengan naiknya temperatur aktivasi dan jumlah penambahan aktivator ($NaNH_2$), maka perolehan *yield N-doped hard carbon* dan kandungan % nitrogen dalam *N-doped hard carbon* akan semakin berkurang.
2. Berdasarkan analisis SEM, produk *N-doped hard carbon* yang disintesis melalui proses karbonisasi dua tahap menghasilkan morfologi yang berupa *microsphere* dengan terbentuknya pori-pori yang cukup banyak, sedangkan produk *N-doped hard carbon* yang disintesis melalui proses karbonisasi satu tahap menghasilkan morfologi dengan bentuk *flakes* atau lembaran lembaran yang tersusun secara berantakan dan memiliki pori yang cenderung lebih sedikit.
3. Berdasarkan analisis EDS, produk *N-doped hard carbon* memiliki kandungan nitrogen yang bervariasi antara 0,4 % – 1,4 %. Kandungan nitrogen pada sampel yang dikarbonisasi dua tahap memiliki kandungan % nitrogen yang lebih besar.
4. Berdasarkan analisis XRD, produk *N-doped hard carbon* dari proses karbonisasi dua tahap dan satu tahap memiliki *interlayer spacing* di rentang 0,37 – 0,389 nm, dimana *interlayer spacing* pada proses karbonisasi dua tahap sedikit lebih besar dibandingkan karbonisasi satu tahap. Selain itu, diperoleh nilai *intercrystallite* yang berkisar diantara 0,20 nm – 0,22 nm, nilai panjang lateral (La) yang berkisar diantara 4,4 nm – 5,6 nm, dan tersusun atas 3 – 4 lapisan *graphene*. Pada analisa kristalinitas XRD menunjukan bahwa produk *N-doped hard carbon* dari proses karbonisasi satu tahap memiliki komposisi *amorphous* yang lebih besar (mencapai 71,23 % *amorphous*) dibandingkan dari proses karbonisasi dua tahap (hanya mencapai 67,44 % *amorphous*).
5. Proses karbonisasi dua tahap menghasilkan *N-doped hard carbon* yang lebih baik dibandingkan dengan proses karbonisasi satu tahap karena menghasilkan *interlayer spacing* yang cenderung sedikit lebih besar dan memiliki kandungan % nitrogen yang lebih banyak.

5.2 Saran

Untuk pengembangan kegiatan penelitian selanjutnya, terdapat beberapa saran yang dapat dipertimbangkan sebagai berikut.

1. Pengujian secara elektrokimia sampel *N-doped hard carbon* sebagai material anoda *sodium-ion batteries* (SIB).
2. Pengujian analisis *X-ray Photoelectron Spectroscopy* (XPS) untuk mengetahui senyawa nitrogen yang terdoping pada *N-doped hard carbon*

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