



Intercalation of magnesium into boron/carbon/nitrogen materials based on the graphite network

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Background



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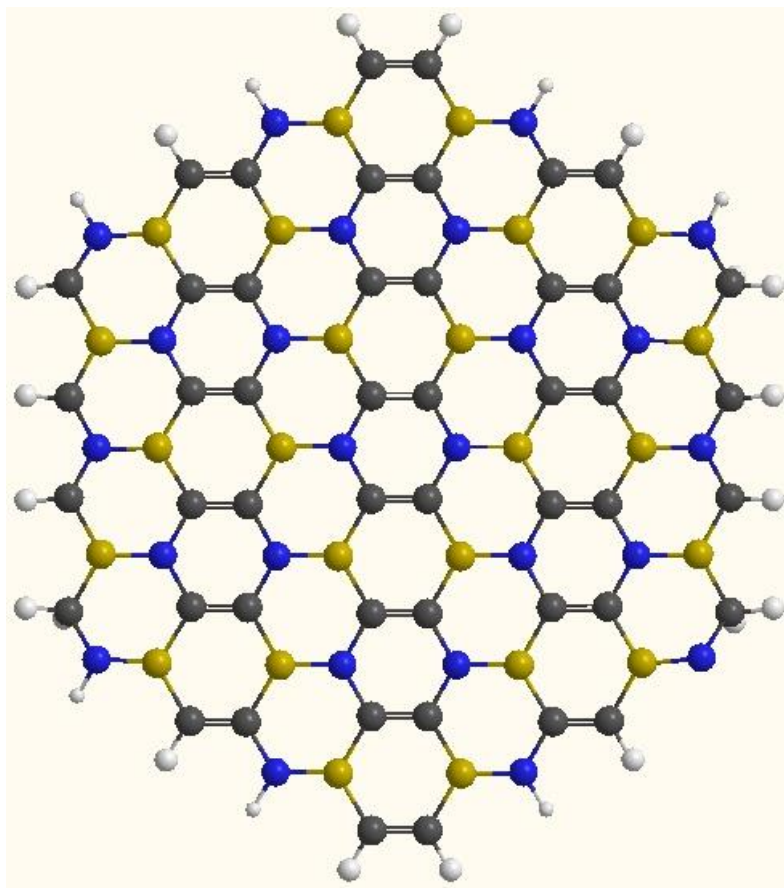


Fig.1 BC_2N

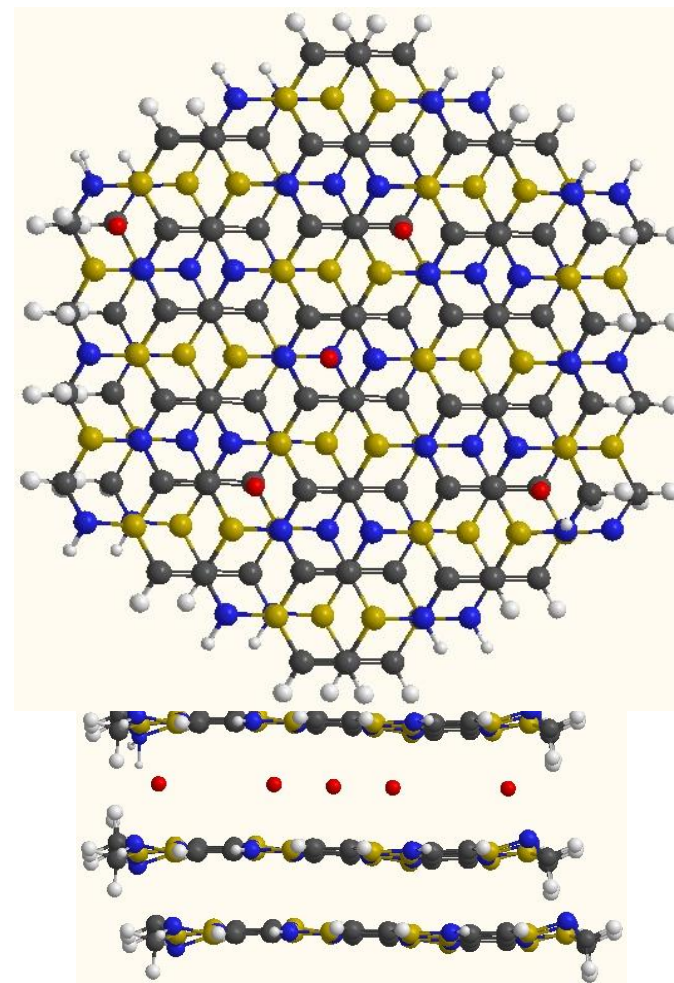


Fig.2 $Mg-BC_2N^1$

1) M. Kawaguchi, and A. Kurasaki, Chem. Comm, 48 (2012) 6897-6899.

Purpose of this study



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- If Mg could be intercalated into B/C/N materials to make 1st stage compound by electrochemical method, it would be applied to Mg ion batteries.

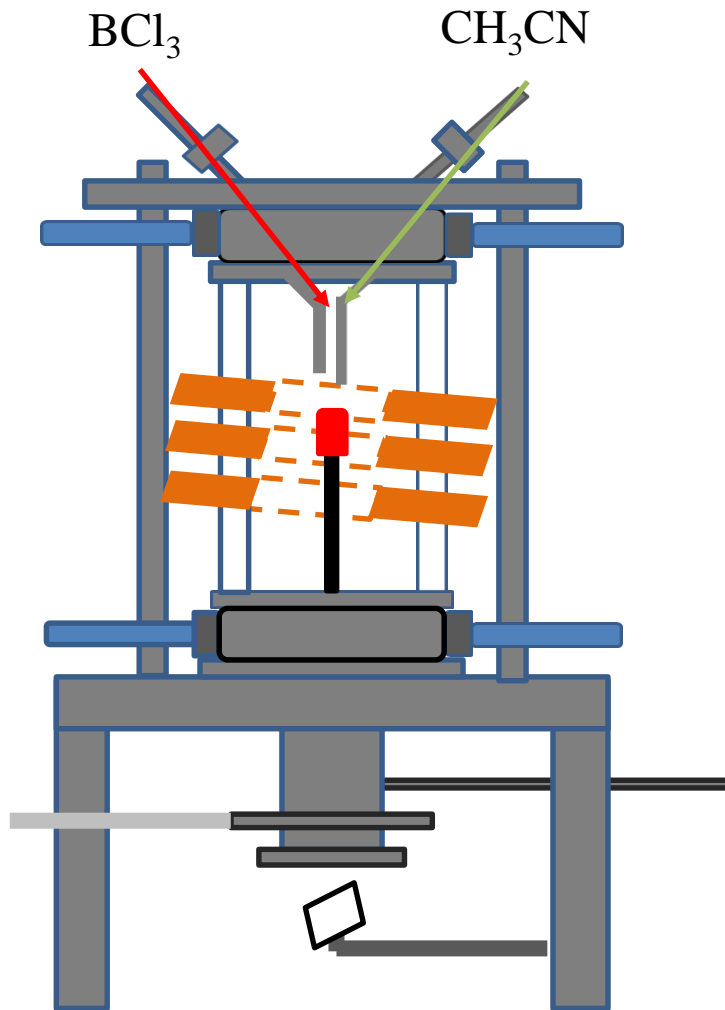


- In this study we tried to intercalate Mg into B/C/N materials by vapor phase reaction and liquid alloy method.

Preparation of B/C/N material



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Synthetic condition

$BC_xN_y(1:1)$

BCl_3 : 40 cc/min

CH_3CN : 40 cc/min

$BC_xN_y(2:1)$

BCl_3 : 80 cc/min

CH_3CN : 40 cc/min

Reaction temperature : 2070 K

Characterization of BC_xN_y



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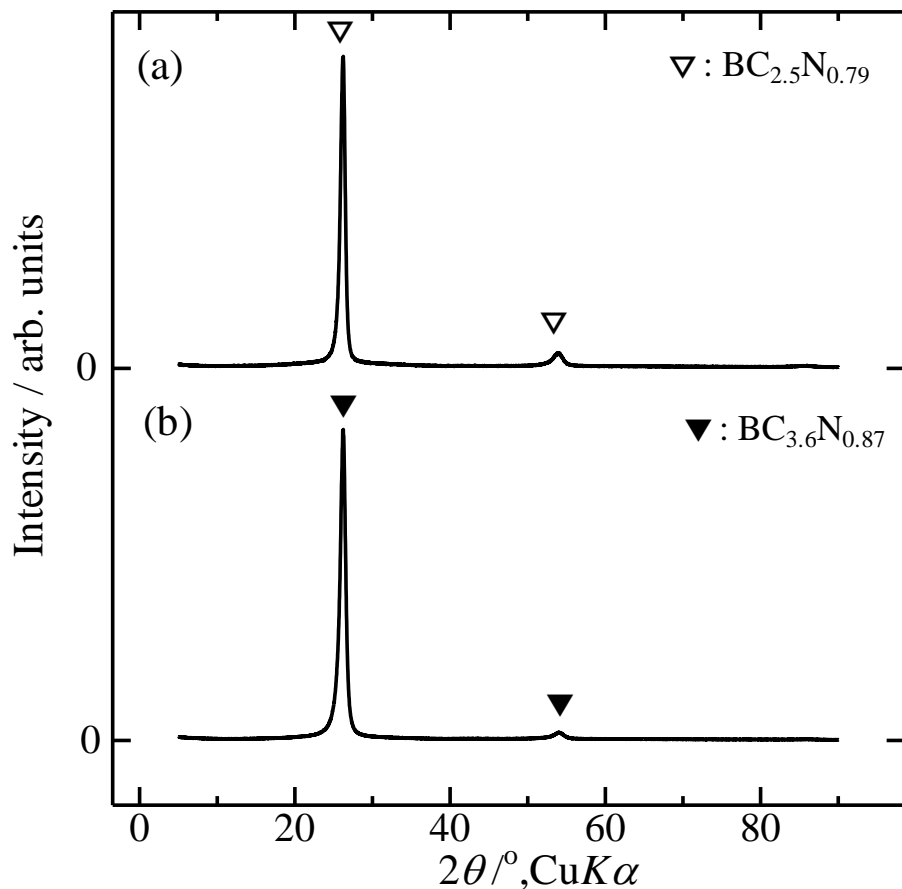


Fig.3 X-ray diffraction patterns of (a) $BC_{2.5}N_{0.79}$ and (b) $BC_{3.6}N_{0.87}$ prepared at 2070 K.

Table 1 Relation between compositions of B/C/N materials and flow ratio.
Reaction temperature 2070 K

	BC_xN_y (1:1)	BC_xN_y (2:1)
Composition	$BC_{3.6}N_{0.87}$	$BC_{2.5}N_{0.79}$

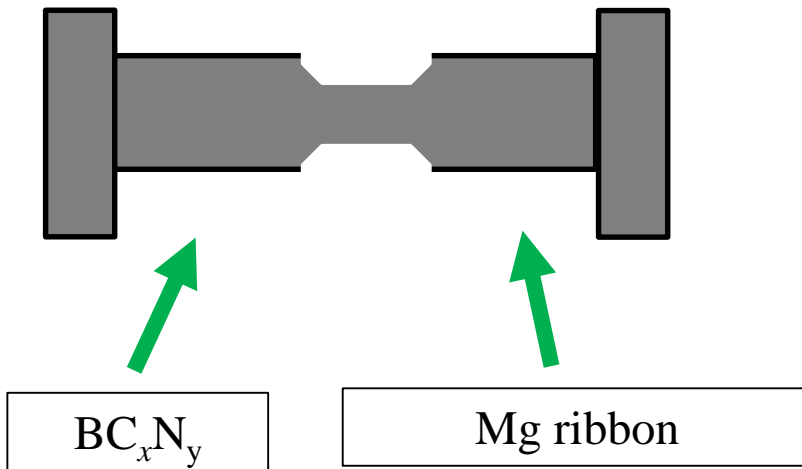
Table 2 XRD data of $BC_{2.5}N_{0.79}$

$2\theta / ^\circ$	d / pm	hkl
26.16	341	002
53.90	170	004

Table 3 XRD data of $BC_{3.6}N_{0.87}$

$2\theta / ^\circ$	d / pm	hkl
26.22	340	002
54.02	170	004

The intercalation of Mg into BC_xN_y by using the vapor phase reaction



Synthesis condition

Reaction temperature: 820 K

Reaction time : 2 weeks

BC_xN_y : Mg = 1 : 2 (Weight ratio)

In an Ar glove box.

XRD pattern of Mg-BC_xN_y

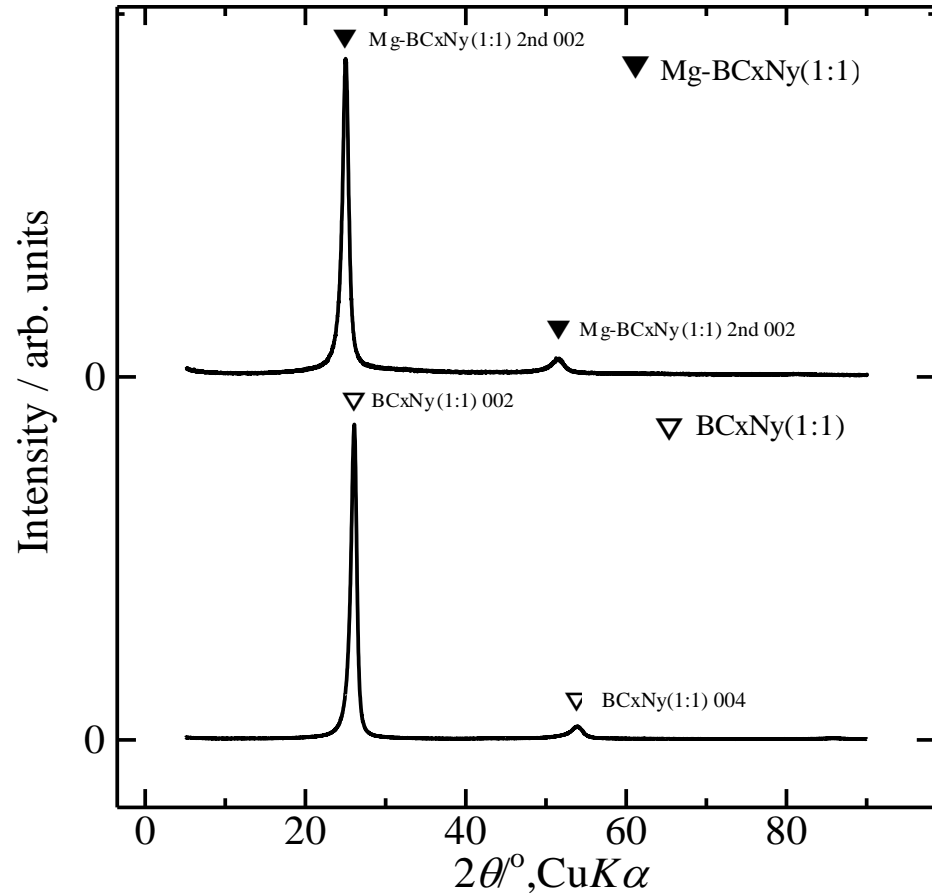


Fig.4 (a) Mg intercalated BC_xN_y (1:1)
(b) The original BC_xN_y(1:1) 2070 K film

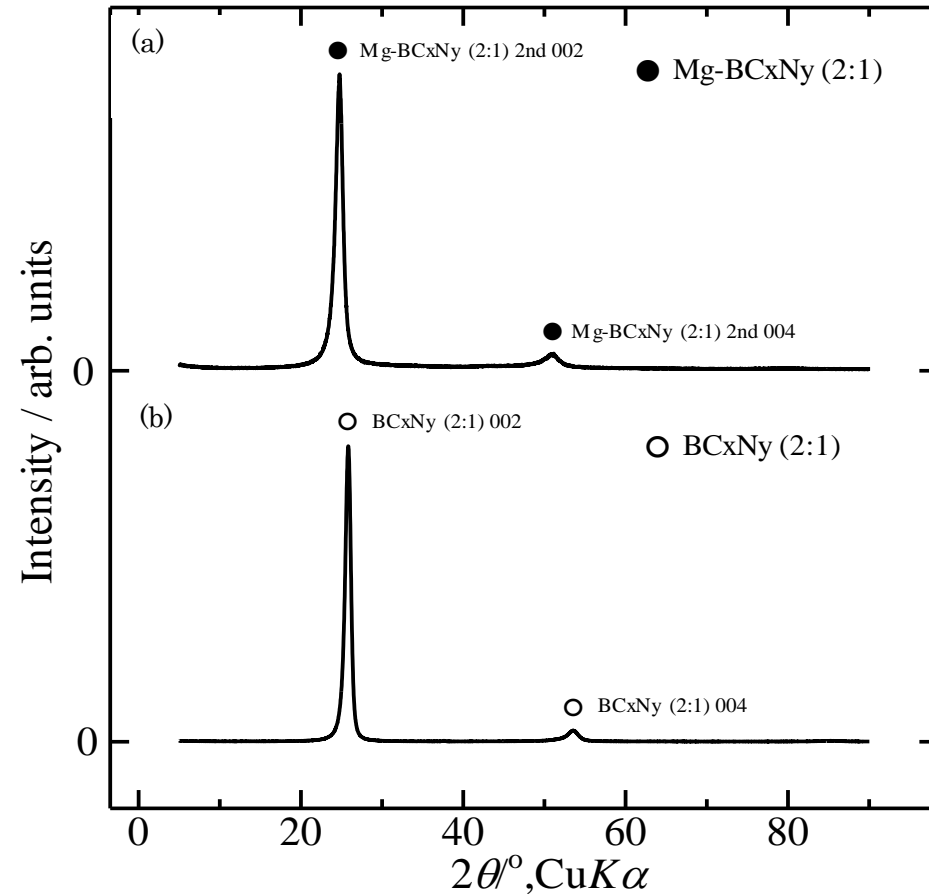
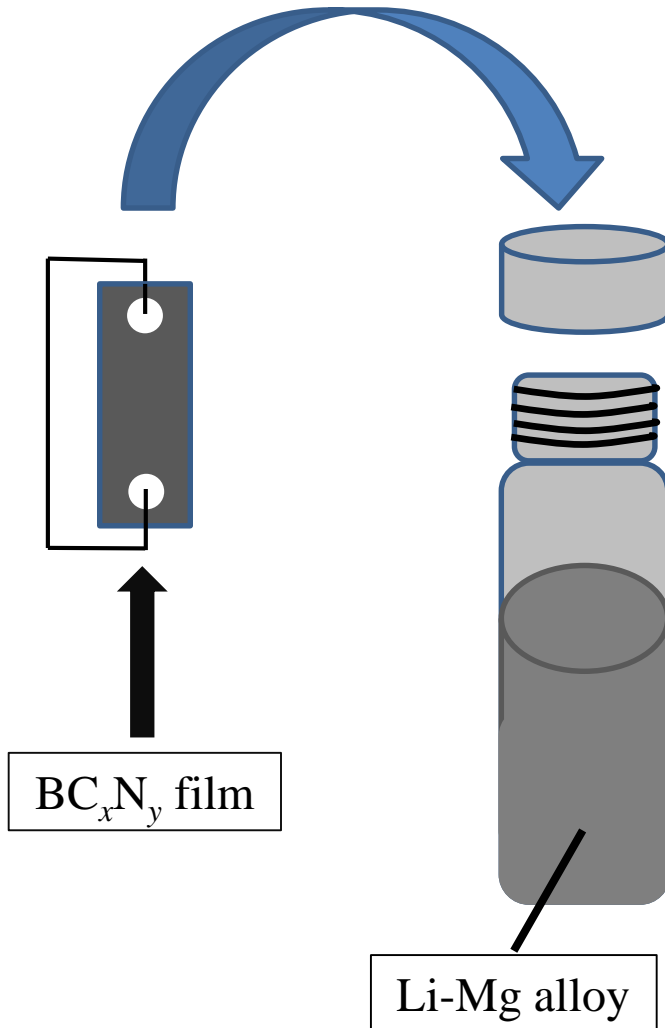


Fig.5 (a) Mg intercalated BC_xN_y (2:1)
(b) The original BC_xN_y(2:1) 2070 K film

The intercalation of Mg into BC_xN_y by using the liquid alloy method



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Experiment condition using Li-Mg liquid alloy

Li-Mg alloy Atomic ratio, Li : Mg = 3 : 7

Reaction temperature : 690 K

Reaction time : 1 week

In an Ar glove box.

The intercalation of Mg into BC_xN_y by using the liquid alloy method



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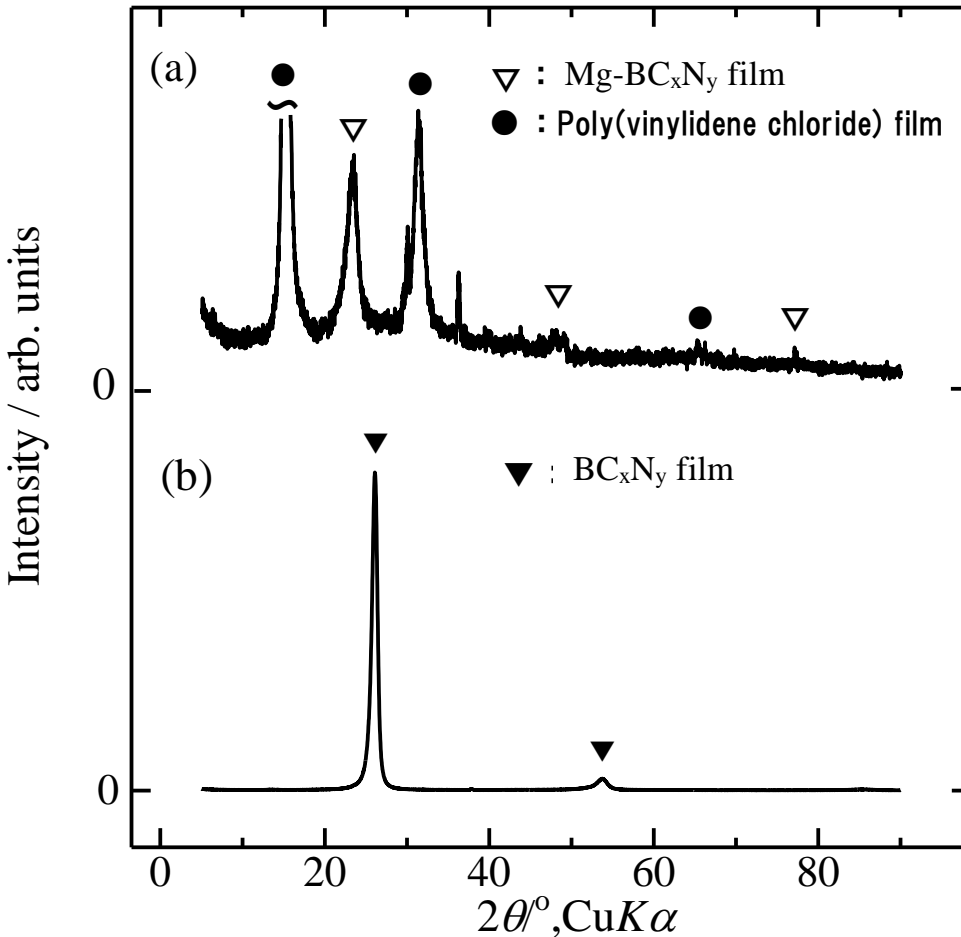


Table4 XRD data of Mg intercalated $BC_{3.6}N_{0.87}$.

$2\theta/^\circ$	d/pm	hkl
23.40	380	Mg- BC_xN_y 1st (001)
47.96	190	Mg- BC_xN_y 1st (002)
77.12	124	Mg- BC_xN_y 1st (003)

Table5 XRD data of $BC_{3.6}N_{0.87}$ prepared at 2070 K.

$2\theta/^\circ$	d/pm	hkl
26.06	342	BC_xN_y (002)
53.70	171	BC_xN_y (004)

Fig.6 X-ray diffraction pattern of (a) the Mg intercalated $BC_{3.6}N_{0.87}$ and (b) the original $BC_{3.6}N_{0.87}$.

Summary



- The Mg intercalated BC_xN_y , which was a second stage compound, was made through vapor phase reaction of Mg with BC_xN_y .
- The intercalation of Mg into BC_xN_y was performed through liquid alloy method to form a first stage compound whose d -spacing was 380 pm.

Possible application in the future



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- Anode of Mg ion batteries
- Super conductors^[1,2]

[1] M. Benkraouda, J. Suoercond. Novel. Magn., **15**, (2002) 659

[2] W. Chen, J. Appl. Phys., **114** (2013) 173906