Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Mechanochemical Reaction of Al and Melamine: A Potential Approach towards the In-situ Synthesis of Aluminum Nitride-Carbon Nanotube Nanocomposites

Seyyed Amin Rounaghi[1,*], Hossein Eshghi[2], Sergio Scudino[3], Elaheh Esmaeili[4], Ali-Reza Kiani-Rashid[5], Jürgen Eckert[6,7,**]

[1] Department of Materials Engineering, Birjand University of Technology, 9719866981 Birjand, Iran.

[2] Department of Chemistry, Faculty of Sciences, Ferdowsi University of Mashhad, 91775-1436 Mashhad, Iran

[3] Institute for Complex Materials, IFW Dresden, Helmholtzstraße 20, D-01069 Dresden, Germany.

[4] Department of Chemical Engineering, Birjand University of Technology, 9719866981 Birjand, Iran.

[5] Department of Materials Engineering, Ferdowsi University of Mashhad, 91775-1111, Mashhad, Iran.

[6] Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, Jahnstraße 12, A-8700 Leoben, Austria.

[7] Department Materials Physics, Montanuniversität Leoben, Jahnstraße 12, A-8700 Leoben, Austria.

*) Corresponding author. E-mail address: rounaghi@birjandut.ac.ir

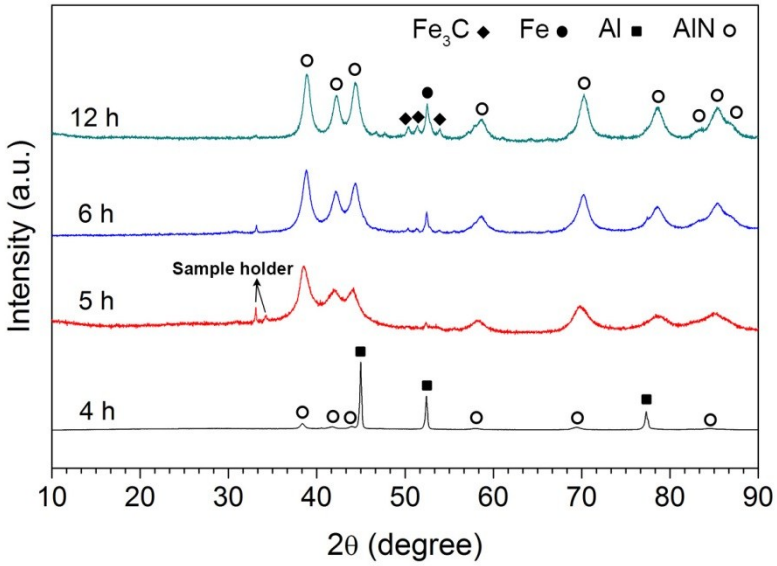

Figure s1. XRD patterns of the samples milled for various times after isochronal heating to 1000 °C at 20 °C/min.

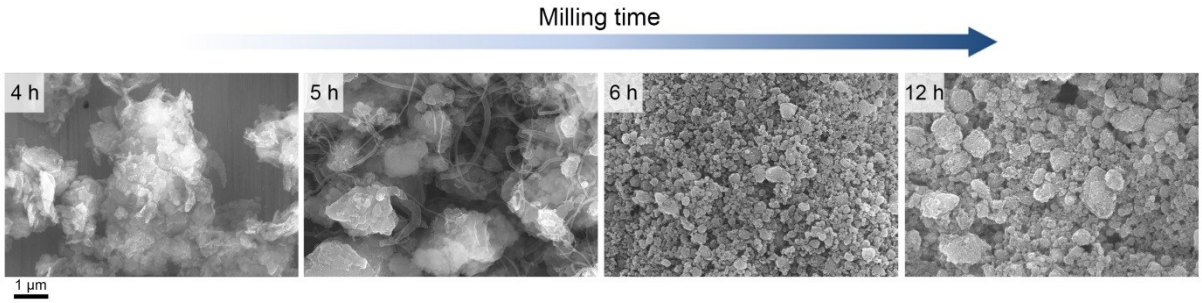

Figure s2. SEM images of the samples milled for various times after isochronal heating to 1000 °C at 20 °C/min.

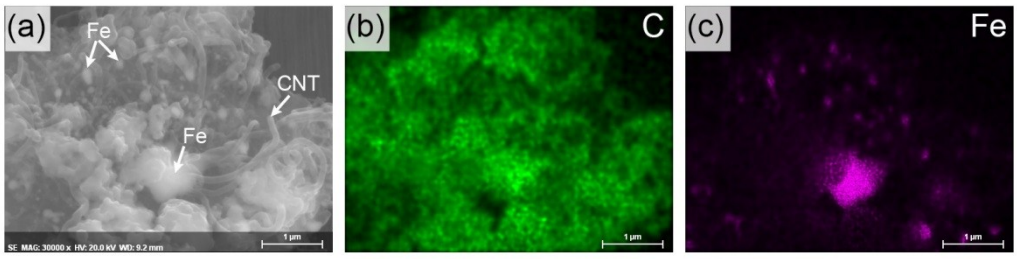

Figure s3. a) Typical SEM image of the powder mixture milled for 5 h heated at 20 °C/min to 800 °C in argon; b) and c) display the results of the corresponding EDX mapping analysis.

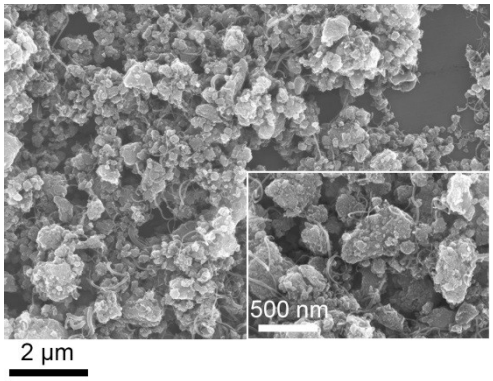

Figure s4. Typical SEM image of the 5 h milled sample after isothermal annealing at 1000 °C for 3 h in argon atmosphere. The inset provides a higher magnification image of the corresponding microstructure.

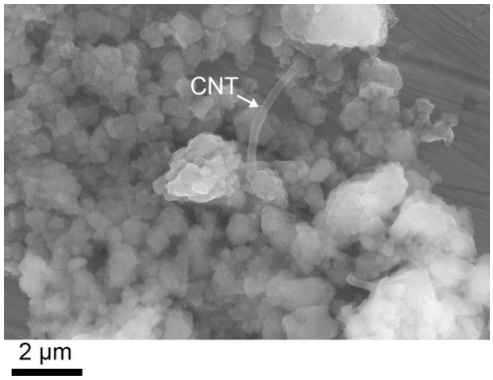

Figure s5. Typical SEM image of the powder mixture milled for 9 h in WC vials after isochronal heating at 20 °C/min to 1000 °C in argon atmosphere.

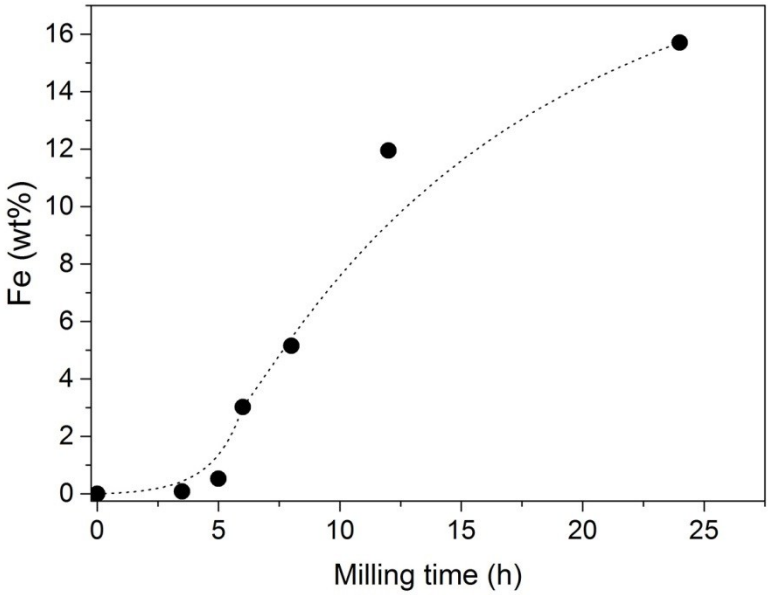

Figure s6. Iron content of the Al-melamine powders as a function of milling time.

(The error values are less than 6%)

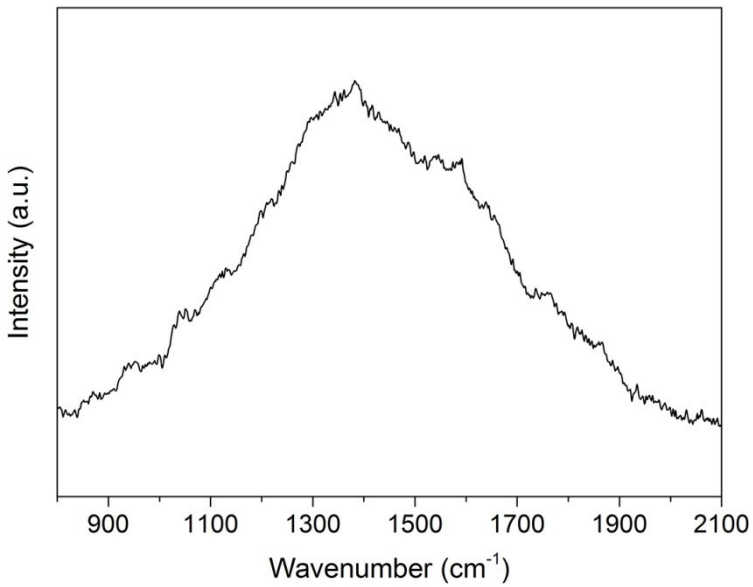

Figure s7. Raman spectrum of the sample with Al/M = 4 milled for 6 h.

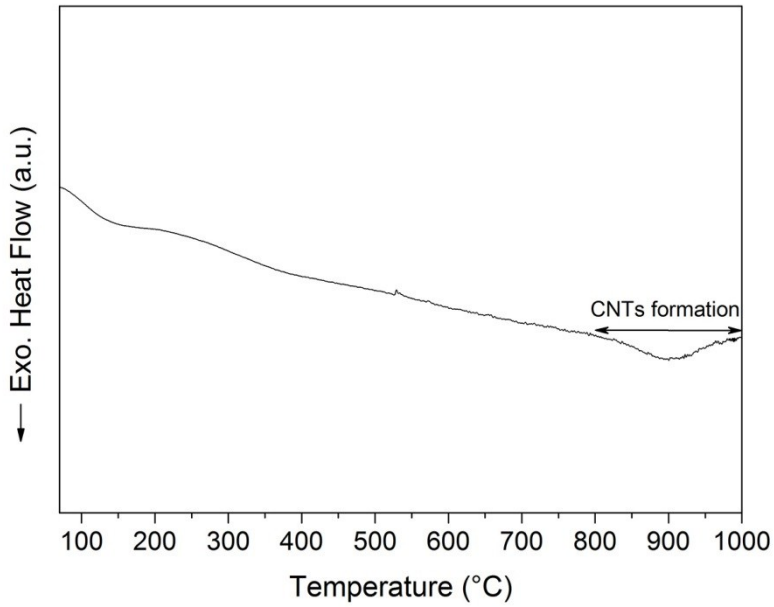

Figure s8. DSC curve (heating rate 20 °C/min) of the sample milled for 6 h with Al/M = 4 in argon flux.

Table s1. Summary of bond assignments representing the structure of carbonaceous intermediates synthesized after 5 h milling.

Band name	Band position (cm^{-1})	Description	References
R_{CO}	1700-1850	Carbonyl group (C=O)	1
R_{OH}	1650-1700	Hydroxyl group (O–H)	1
G	1581	E_{2g} mode of graphite; aromatic ring quadrant breathing; sp^2 C=C	1, 2
G_L	1510-1540	Conjugated 3-5 aromatic rings; amorphous carbon structures	3-5
V_R	1440-1460	Amorphous carbon structures; methylene or methyl group; semicircle breathing of aromatic rings	1, 3-5
V_L	1360-1390	Amorphous carbon structures; methyl group; semicircle breathing of aromatic rings	1, 3-5
D	1300-1340	A_{1g} breathing mode of disordered graphitic ring systems with more than 6 aromatic rings	1, 2, 5
S_1	1210-1230	C-H on aromatic rings; sp^2–sp^3 bonded carbon on para-aromatics, $C_{aromatic}$–C_{alkyl}; C–C on hydroaromatic rings	1, 5
S_2	1050-1080	C–H on aromatic or ortho-disubstituted rings	1, 5
S_3, S_4	750-960	C–H on aromatic rings; C–C on alkanes and cyclic alkanes	1, 5

References

1. D. Lin-Vien, N. B. Colthup, W. G. Fateley and J. G. Grasselli, *The handbook of infrared and Raman characteristic frequencies of organic molecules*, Academic Press, Boston, 1991.
2. M. S. Dresselhaus, A. Jorio, M. Hofmann, G. Dresselhaus and R. Saito, *Nano Lett.*, 2010, **10**, 751-758.
3. J. McDonald-Wharry, M. Manley-Harris and K. Pickering, *Carbon*, 2013, **59**, 383-405.
4. H. Wu, K. Yip, F. Tian, Z. Xie and C. Z. Li, *Ind. Eng. Chem. Res.*, 2009, **48**, 10431-10438.
5. X. Li, J. I. Hayashi and C. Z. Li, *Fuel*, 2006, **85**, 1700-1707.