

## Supporting Information

### **High-Modulus All-carbon Ladder Polymer of Hydroquinone and Formaldehyde that Bridges the Gap between Single Strand Polymers and Graphene Nanoribbons**

Shao-ZhongZeng,<sup>a,d</sup> Neng-ZhiJin,<sup>b</sup> Hai-Lu Zhang,<sup>c</sup> Bin Hai,<sup>a</sup> Xiao-HuaChen,<sup>a</sup> and Jianlin Shi\*,<sup>d</sup>

<sup>a</sup>Chery Science Research Institute, Chery Automobile Co. Ltd; 8 Chang-chun road, Wuhu 241006, Anhui, China

<sup>b</sup>Gansu Computing Center, Lanzhou 730030, Gansu, China

<sup>c</sup>Suzhou Institute of Nano-tech and Nano-bionics, Chinese Academy of Sciences, 398 Ruoshui road, Suzhou 215123, China

<sup>d</sup>State Key Laboratory of High-Performance Ceramics and Superfine Microstructures, Shanghai Institute of Ceramics, Chinese Academy of Sciences, 1295 Ding-xi Road, Shanghai 200050, China.

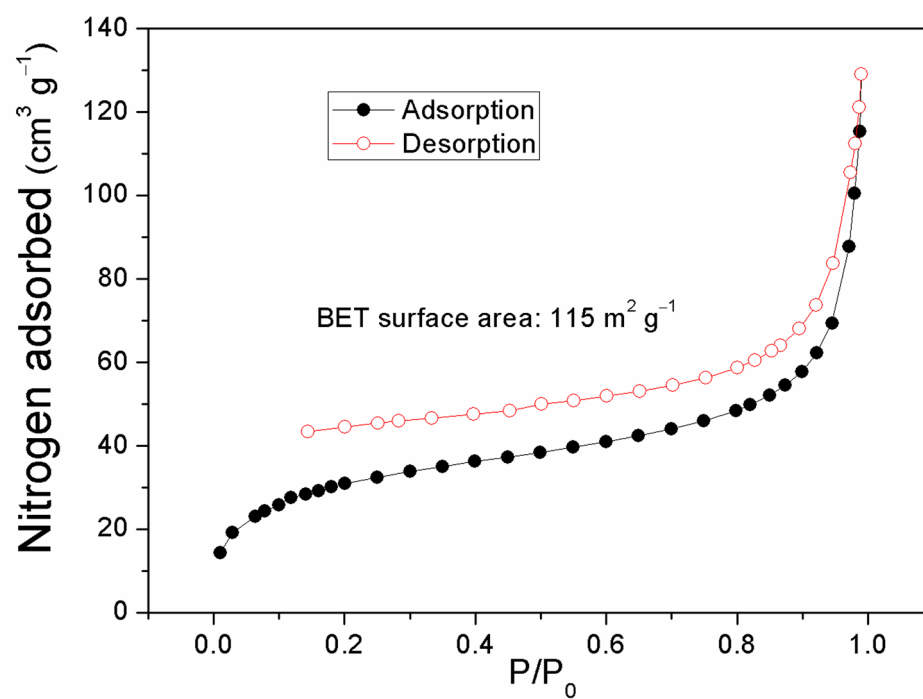


Fig. S1. Nitrogen adsorption (filled symbols) and desorption (open symbols) isotherms for LPHF at 77 K.

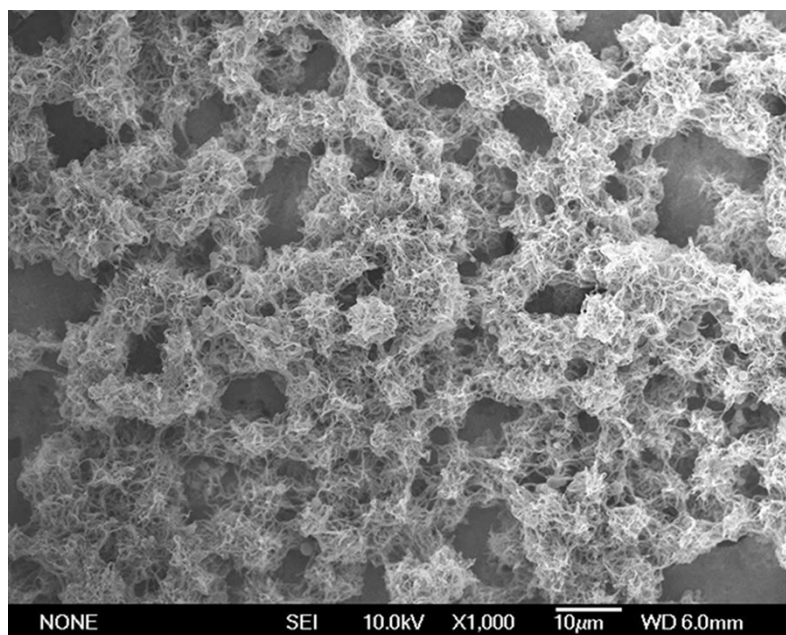


Fig. S2. SEM image of LPHF.

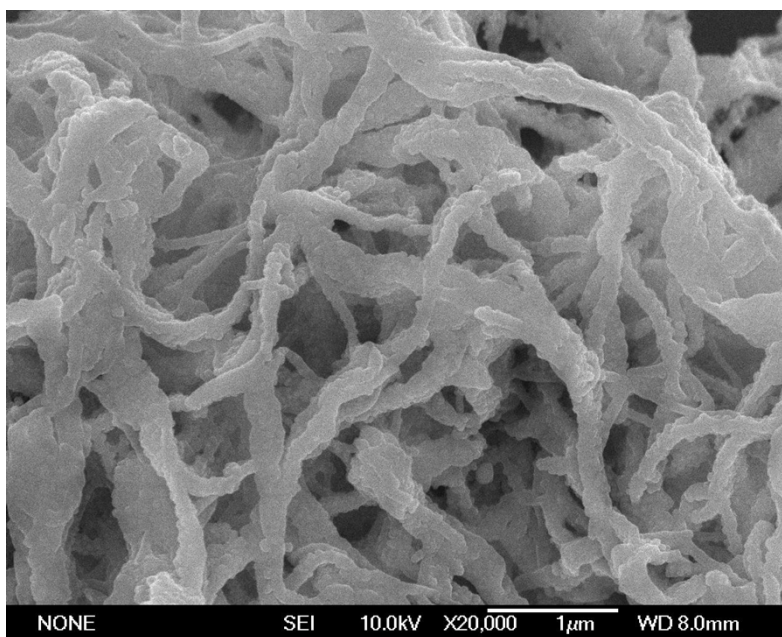


Fig. S3. SEM image of OLPHF-Ag.

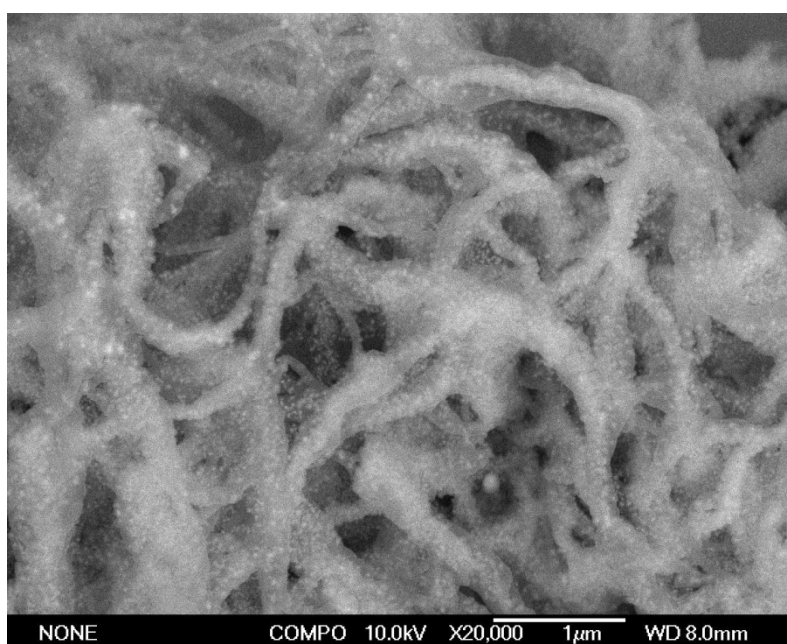


Fig. S4. The backscattered electron image of OLPHF-Ag. This image corresponds to the SEM image in Fig. S3. The numerous bright dots are the silver nanoparticles.

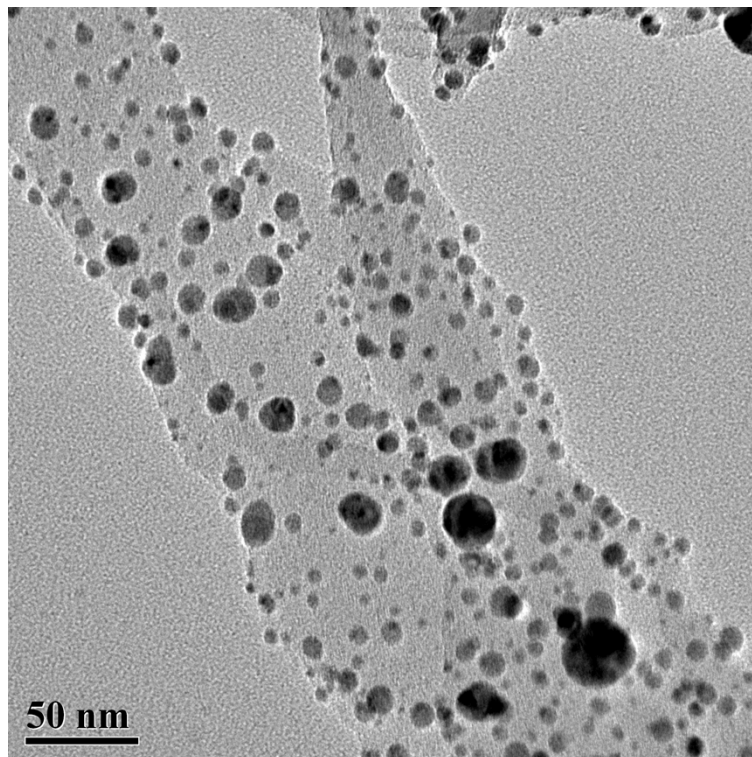


Fig. S5. TEM image of OLPHF-Ag, the numerous black dots are the silver nanoparticles.

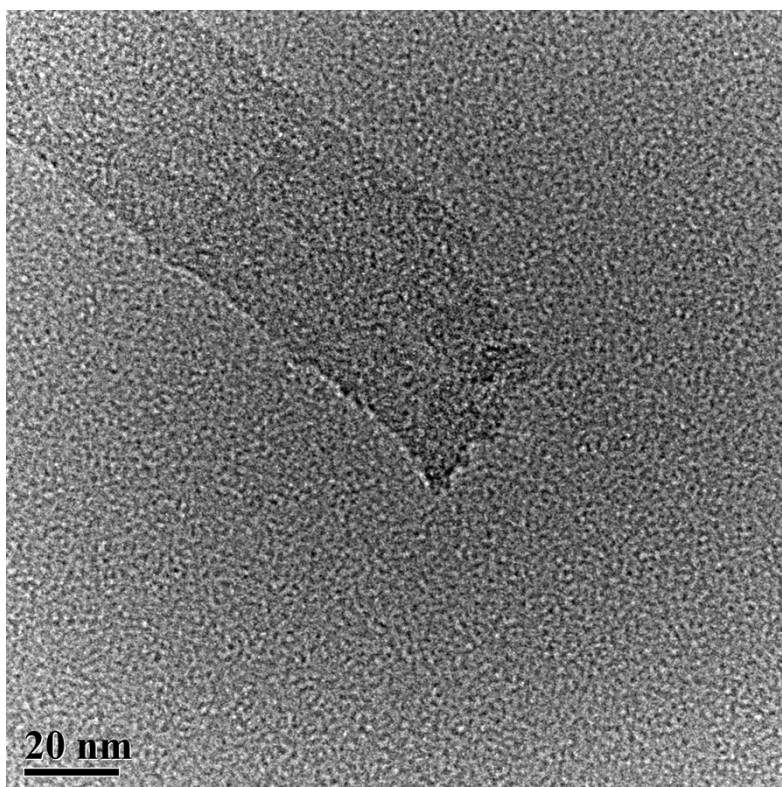


Fig. S6. TEM image of LPHF.

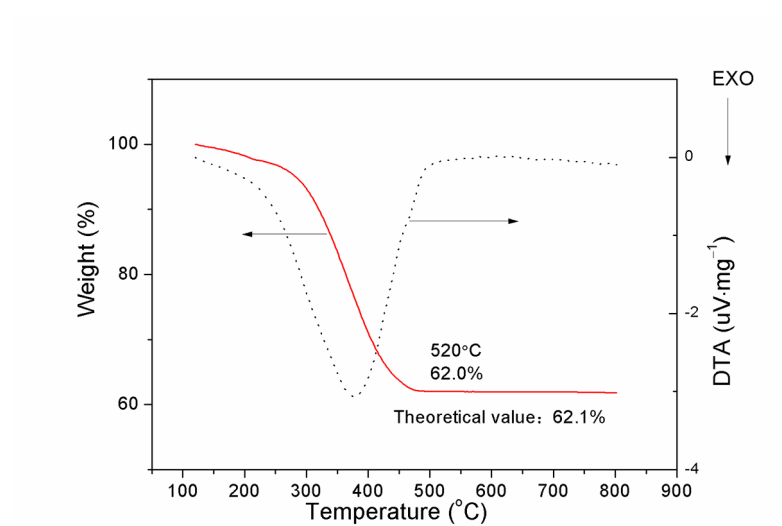


Fig. S7. The combined TG-DTA curves for OLPHF-Ag composite recorded in air follow.

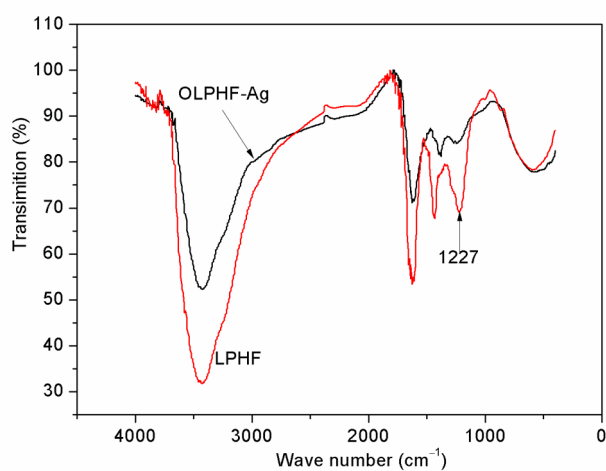


Fig. S8. FT-IR spectra of LPHF and OLPHF-Ag composite. The peak at  $1227\text{ cm}^{-1}$  results from the stretching vibration of C–O bonds, which has been largely weakened after oxidation with  $\text{Ag}(\text{NH}_3)_2^+$ .

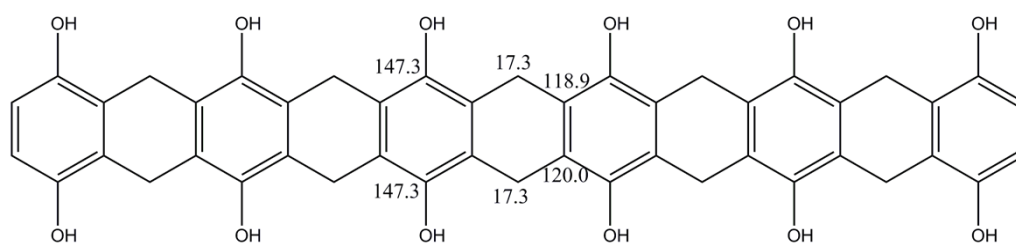


Fig. S9. Schematics of oligomer structure with 6 hydroquinone units.

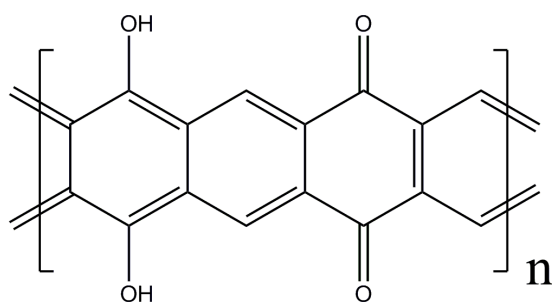
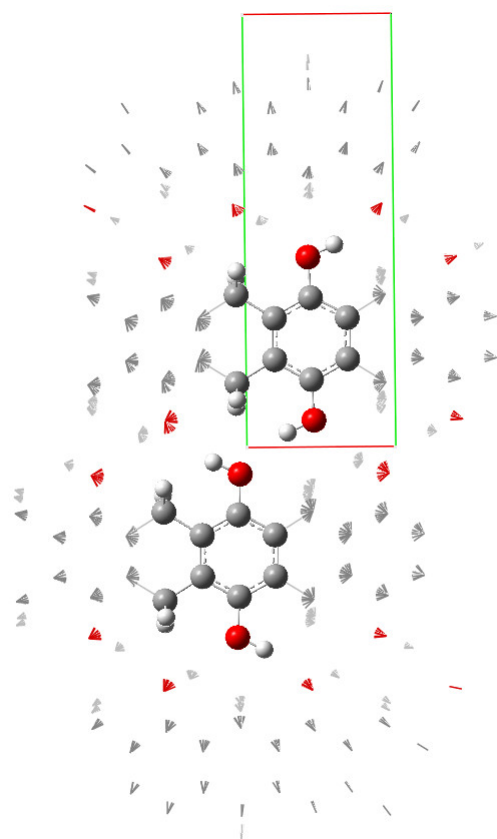
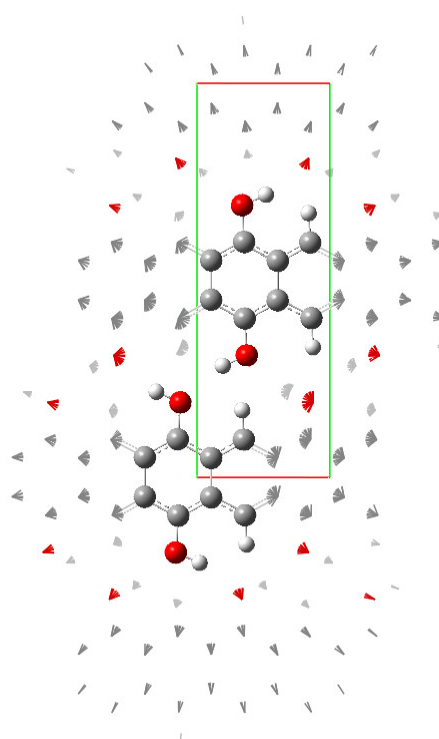


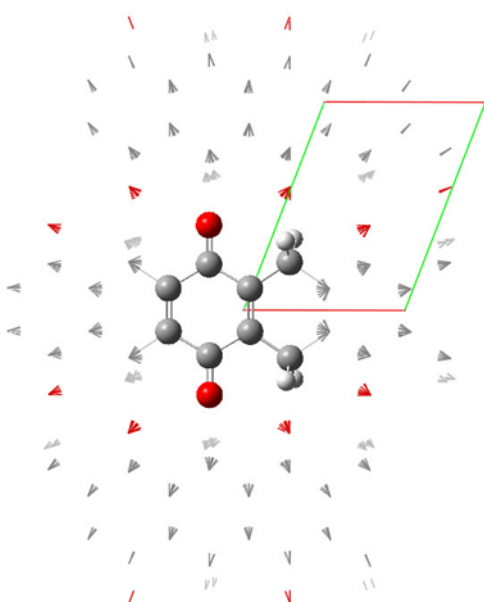
Fig. S10. Schematics of the hypothetical polymer constructed alternatively with LPBH and OLPBH units.



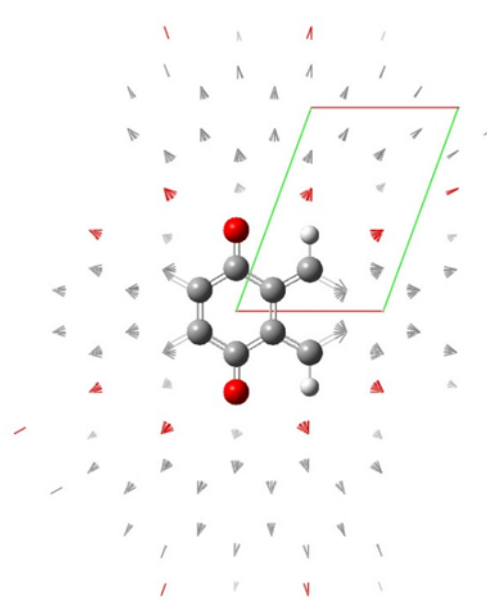
(a) LPHF  
Width=0.73 nm



(b) LPBH  
Width=0.73 nm



(c) OLPHF  
Width=0.65 nm



(d) OLPBH  
Width=0.65 nm

Fig. S11. Schematics of 2D molecular crystal tilted by macromolecular chains.

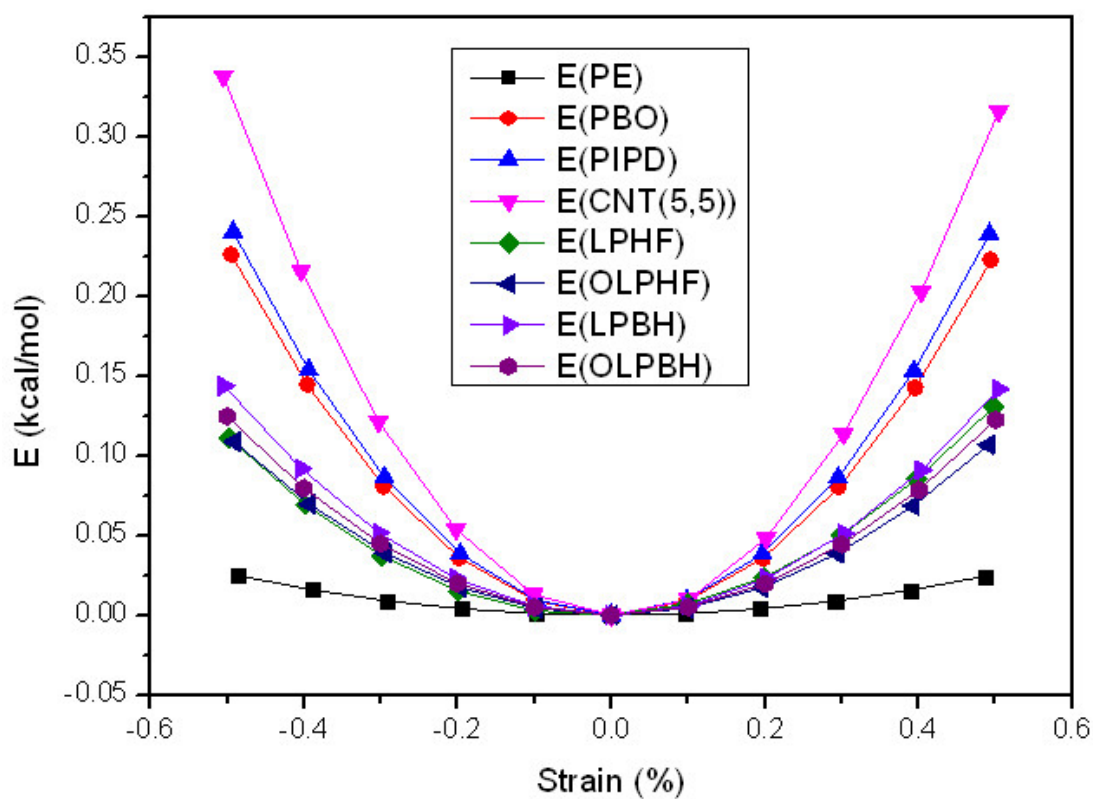


Fig. S12. The energy curves of PE, PBO, PIPD, CNT(5,5), LPHF, OLPHF, LPBH and OLPBH.

Table S1. The estimated cross areas and the corresponding moduli of LPHF, OLPHF, LPBH, OLPBH, PAC and CNT(5,5).<sup>1</sup>

| Polymers | Width of<br>macromolecular<br>chain (nm) | Thickness of<br>macromolecular<br>chain (nm) | Cross area<br>(nm <sup>2</sup> ) | Modulus<br>(GPa) |
|----------|--|--|----------------------------------|------------------|
| LPHF     | 0.73                                     | 0.35   | 0.2555                           | 528              |
| OLPHF    | 0.65                                     | 0.35   | 0.2275                           | 536              |
| LPBH     | 0.73                                     | 0.35   | 0.2555                           | 620              |
| OLPBH    | 0.65                                     | 0.35   | 0.2275                           | 603              |
| PAC      | 0.61                                     | 0.35   | 0.2135                           | 745              |
| CNT(5,5) | 2.10                                     | 0.33   | 0.6930                           | 1046             |

**References:**

- (1) Shokrieh, M. M.; Rafiee, R.; *Mater. Des.* **2010**, *31*, 790.