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## COMMUNICATION

Imidazolium-based ionic liquids functionalized reduced graphene oxide supported palladium as a reusable catalyst for Suzuki-Miyaura reactions

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A novel palladium immobilized on reduced graphene oxide heterogeneous catalyst was prepared. The reduced graphene oxide was functionalized by an imidazolium-based ionic liquids containing polyethylene glycol monomethyl ether moieties. The prepared catalyst can achieve Suzuki-Miyaura reactions efficiently in green solvent under mild conditions and could be recycled through five catalytic runs without loss of activity.

Palladium-catalyzed transformations have seen a fascinating development in the past decades.<sup>1</sup> It plays a crucial role in organic synthesis by catalyzing various common transformations especially carbon-carbon and carbonheteroatom bond formation.<sup>2</sup> Homogeneous palladium catalysts feature high levels of activity since they are uniform on a molecular level and readily dissolved in the reaction medium. Homogeneous catalysts present several drawbacks such as a loss of expensive metal, difficult separation from the reaction mixture, deactivation of catalyst through the agglomeration and difficult recycling, which limits the largescale application in industry.<sup>3</sup> Therefore, designing a heterogeneous palladium catalyst with high efficiency is of great interest for both academic and industry fields. In this context, various inorganic and organic supports have been explored, such as mesoporous and amorphous silica, polymers,<sup>5</sup> metal oxides<sup>6</sup>, magnetic nanoparticles<sup>7</sup> and MOF.<sup>8</sup> However, most of them have serious drawbacks like a complicated synthesis process, hampered diffusion kinetics, or tedious separation.9

The concept of supported ionic liquids (SILs) becomes very attractive recently because they refer to ionic liquids (ILs) that are immobilized on supports by either covalent or noncovalent bonds and retain the advantages of ILs and supports.<sup>10</sup> ILs have been linked to a variety of supports, such as silica,<sup>11</sup> resins,<sup>12</sup>

and magnetic nanoparticles.<sup>13</sup> They have been used as green media and functional materials for supports of catalysts, surface modifying agents, stationary phases in separation technologies and electrodes in electrochemistry.<sup>14</sup> SILs are able to stabilize the nanoparticles and create an ionic liquid based nano-environment on the surface of material to enhance their interaction with substrates.<sup>15</sup> Thus, SILs can improve the reaction efficiency when applied as a support in catalysis. Design and preparation of novel and efficient heterogeneous metal catalyst containing ILs may afford an opportunity to practical engineering applications.<sup>16</sup>

Over the last decade, remarkable progress has been accomplished in the development of new graphene derivatives as benign, abundant and readily available catalysts and supports for organic transformations.<sup>17</sup> Among them, highly oxidized graphene oxide (GO) is easily functionalized as supports to covalent immobilization of homogeneous catalyst.<sup>18</sup> Alone this line, we report here a novel Pd on GObased catalyst, consisting of imidazolium-based ILs containing polyethylene glycol monomethyl ether (mPEG), which have the ability to stabilize Pd nanoparticles and improve water dispersivity for use in aqueous phase catalysis.<sup>19</sup> The activity of the catalyst was demonstrated by employing the Suzuki-Miyaura coupling as model reactions. The catalysts promoted formation of C-C bonds in water at room temperature and could be reused for five subsequent runs without loss of activity and there was no need for washing and purification of the catalyst after each run.

The immobilization Pd and Pd<sup>II</sup> onto the IL-functionalized GO was illustrated in Scheme 1. GO was reduced by ascorbic acid to obtain reduced graphene oxide (RGO).<sup>20</sup> Then, the azide-functionalized RGO was achieved by a reported procedure<sup>21</sup> and the ILs were attached to the RGO by Cu-catalyzed azide-alkyne click reaction. Ultimately, the IL-functionalized RGO (RGO-IL) was reacted with Pd(OAc)<sub>2</sub> generating the heterogeneous Pd catalyst (RGO-IL-Pd). Two catalysts with imidazolium moiety modified by mPEG<sub>200</sub> (RGO-IL-Pd **1a**) and mPEG<sub>500</sub> (RGO-IL-Pd **1b**) were prepared.

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X-ray photoelectron spectroscopy (XPS) was performed for RGO-IL-Pd 1a to illustrate the surface chemical composition of the catalyst. As shown in Figure 1, the XPS spectrum confirms that ILs were anchored on RGO. Fresh sample exhibited a higher percentage of Pd<sup>II</sup> with respect to metallic Pd indicating that the process was able to reduce part of Pd<sup>"</sup>. The imidazolium-based ILs were potential to act as both to s for Pd<sup>II</sup> and stabilizers for PdNPs. Specifically, this raised possibility that the nanoparticles acted as both catalyst and reservoirs for Pd<sup>II</sup> species such as NHC-Pd.<sup>22</sup> The measure indicated the successful functionalization of RGO with ILs and Pd. Thermogravimetric analysis (TGA) was further used to study the composition of RGO-IL containing mPEG<sub>200</sub> moiety and the hybrid material showed good thermal stability up to 200 °C (Figure 2). According to BET, immobilization of Pd caused a small decrease in surface area of support. Due to the amorphous carbon peak is too strong, palladium peak is not obvious in the X-ray powder diffraction (XRD) patterns (Figure S1).

The morphology of the catalyst was directly observed by transmission electron microscopy (TEM). As shown in Figure 3, the PdNPs of RGO-IL-Pd **1a** and **1b** have a good distribution throughout the RGO sheets with an average diameter of 3.2 nm and 5.6 nm, respectively. The functional groups on the modified RGO are responsible for stabilizing the palladium nanoparticles against aggregation. As shown in Figure 3b, the crystalline fringe patterns and the lattice fringes align parallel of PdNPs are obvious clearly. The PdNPs aggregated when mPEG moiety was changed to methyl group (RGO-IL-Pd **1c**, see Figure S2).



Figure 1. Survey XPS data for (a) RGO-IL-Pd 1a, (b) N 1s region and (c) Pd 3d region.



Figure 2. TGA analysis of RGO, RGO-Cl, RGO-N<sub>3</sub> and RGO-IL containing mPEG<sub>200</sub> moiety.



**Figure 3.** TEM images of (a) (b) RGO-IL-Pd **1a** and (c) (d) RGO-IL-Pd **1b**. The inlet image shows the size distribution of PdNPs.

C-C cross-coupling reactions, such as Suzuki-Miyaura reaction, are powerful tools for the preparation of natural advanced materials and biologically active products. compounds. Therefore, the prepared RGO-IL-Pd was explored as the catalysts in the Suzuki-Miyaura reaction. For this purpose, coupling of 4-bromoanisole (2a) with phenylboronic acid (3a) was selected as the model reaction. Among the solvents tested,  $H_2O$ -EtOH (1:1 v/v) was the optimal choice (Table 1, entries 1-5). The reaction provided a 96% yield of the desired product 4a with RGO-IL-Pd 1a (0.5 mol%) at room temperature (Table 1, entries 6-8). The commercial Pd/C couldn't catalyze the reaction and 4a was only obtained in a moderate yield with RGO-IL-Pd 1c (Table 1, entries 9-11). It was confirmed that RGO-IL-Pd 1a exhibited the superior catalytic activity and the imidazolium-based IL modified by mPEG played the crucial role. After extensive experiments using different bases, we found that K<sub>2</sub>CO<sub>3</sub> facilitate the reaction most (Table 1, entries 12-14). Finally, the normative reaction conditions were defined. A mixture of 2a and 3a (1.3 equiv.) was reacted in the presence of RGO-IL-Pd 1a (0.5 mol%), K<sub>2</sub>CO<sub>3</sub> (2 equiv.) in H<sub>2</sub>O-EtOH (1:1 v/v) at room temperature for 3 h.

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**Table 1.** Optimization for the Suzuki–Miyaura coupling reaction<sup>a</sup>

	Br C	B(OH) <sub>2</sub>		
M	+	base, solver	nt 🗍	
IVIC	2a 3a	1	MeO	4a
Entry	Catalyst	Solvent	т (°С)	Yield (%) <sup>b</sup>
1 <sup><i>c</i></sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/EtOH (1:1)	80	95
<b>2</b> <sup><i>c</i></sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O	80	46
3 <sup><i>c,d</i></sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O	80	92
4 <sup><i>c</i></sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/THF (1:1)	80	61
5 <sup>c</sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/EtOH (2:1)	80	90
6 <sup><i>c</i></sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/EtOH (1:1)	25	97
7	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/EtOH (1:1)	25	96
8 <sup>e</sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/EtOH (1:1)	25	81
9	RGO-IL-Pd <b>1b</b>	H <sub>2</sub> O/EtOH (1:1)	25	89
10	RGO-IL-Pd <b>1c</b>	H <sub>2</sub> O/EtOH (1:1)	25	74
11	Pd/C	H <sub>2</sub> O/EtOH (1:1)	25	n.d.
12 <sup>f</sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/EtOH (1:1)	25	86
13 <sup><i>g</i></sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/EtOH (1:1)	25	81
14 <sup><i>h</i></sup>	RGO-IL-Pd <b>1a</b>	H <sub>2</sub> O/EtOH (1:1)	25	69

<sup>*a*</sup> Reaction conditions: **2a** (0.5 mmol), **3a** (1.3 equiv.), 0.5 mol% Pd,  $K_2CO_3$  (2 equiv.), solvent (2 mL), 3 h, under air. <sup>*b*</sup> Yield was determined by GC, using *n*-dodecane as the internal standard. <sup>*c*</sup> 1 mol% Pd. <sup>*d*</sup> 8 h. <sup>*e*</sup> 0.25 mol% Pd. <sup>*f*</sup> Cs<sub>2</sub>CO<sub>3</sub> was used as the base. <sup>*g*</sup> KOH was used as the base. <sup>*h*</sup> Et<sub>3</sub>N was used as the base.

After optimization of the reaction conditions, we turned to explore the substrate scope of the established system. A variety of aryl bromides and arylboronic acids with electrondonating or electron-withdrawing functional groups could reacted smoothly, giving the corresponding products in good to excellent yields (Table 2). The substrates carrying substituents at the ortho/meta/para position were well tolerated in this transformation. This catalytic system was also found to be applicable for the gram-scale synthesis of Suzuki-Miyaura coupling reaction (Scheme 2). When 1.1 g of 4bromoanisole was treated with phenylboronic acid in the presence of RGO-IL-Pd 1a (0.5 mol%). The product 4a was isolated in 81% yield (0.89 g) with 3 h. Comparing with other reported heterogeneous Pd catalysts, our method with RGO-IL-Pd 1b is simpler, lower temperature, more efficient and less time consuming for the Suzuki reaction (Table S1).<sup>23</sup>

The recyclability of RGO-IL-Pd **1a** Suzuki-Miyaura coupling reaction was examined. After the reaction, the product was extracted with *n*-hexane and the aqueous phased was loaded with the reactants and base for the next run. Then, the catalyst reused in five consecutive runs without losing of efficiency (Figure 4). TEM analysis of the catalyst after the five run confirmed that the palladium nanoparticles remained monodisperse mostly with a mean diameter of 6.9 nm. (Figure S3). XPS spectrum of catalyst after recovery was similar with the spectrum of fresh catalyst, even most of Pd<sup>II</sup> was reduced to metallic Pd (Figure S4). ICP-MS analysis of palladium content in the filtrate after the first cycle was below 0.3 ppm.

#### Table 2. RGO-IL-Pd 1a catalyzed Suzuki reaction<sup>*a,b*</sup>



<sup>*a*</sup> Reaction conditions: aryl bromide (0.5 mmol), arylboronic acid (1.3 equiv.),  $K_2CO_3$  (2 equiv.), RGO-IL-Pd **1a** (0.5 mol% Pd), r.t. 3 h and  $H_2O$ /EtOH (1:1 v/v, 2 mL). <sup>*b*</sup> Isolated yield.







**Figure 4.** Recycling of the RGO-IL-Pd **1a** in the Suzuki-Miyaura reaction.

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These observations confirmed the high efficacy and robust nature of this catalyst.

In summary, we successfully developed novel, efficient and recyclable Pd catalysts, consisting of mPEGylated imidazoliumbased ionic liquids on RGO. These catalysts were proved to be efficient in Suzuki-Miyaura coupling reaction with green solvent at room temperature. The ILs containing mPEG played an important role in stabilizing the NPs and improving the activity of the catalyst. The catalyst exhibited good reusability and could be reused for five times without significant decrease in catalytic activity.

## Notes and references

Published on 10 January 2018. Downloaded by University of Reading on 16/01/2018 08:55:07

- 1 (a) A. Chen and C. Ostrom, Chem. Rev., 2015, 115, 11999-12044; (b) M. Platon, R. Amardeil, L. Djakovitch and J.-C. Hierso, Chem. Soc. Rev., 2012, 41, 3929-3968.
- 2 (a) P. Ruiz-Castillo and S. L. Buchwald, Chem. Rev., 2016, 116, 12564-12649; (b) A. Balanta, C. Godard and C. Claver, Chem. Soc. Rev., 2011, 40, 4973-4985; (c) N. Miyaura and A. Suzuki, Chem. Rev., 1995, 95, 2457-2483; (d) A. N. Desnoyer and J. A. Love, Chem. Soc. Rev., 2017, 46, 197-238; (e) D. A. Petrone. J. Ye and M. Lautens, Chem. Rev., 2016, 116, 8003-8104; (f) Y. Sumida, T. Kato, S. Yoshida and T. Hosoya, Org. Lett., 2012, 14, 1552-1555.
- (a) A. Monge-Marcet, R. Pleixats, X. Cattoën and M. Wong 3 Chi Man, J. Mol. Catal. A: Chem., 2012, 357, 59-66; (b) L. Yin and J. Liebscher, Chem. Rev., 2007, 107, 133-173; (c) Y. Yu, T. Hu, X. Chen, K. Xu, J. Zhang and J. Huang, Chem Commun, 2011, 47, 3592-3594.
- (a) M. Z. Cai, J. A. Peng, W. Y. Hao and G. D. Ding, Green 4 Chem., 2011, 13, 190-196; (b) R. S. Mane, T. Sasaki and B. M. Bhanage, RSC Adv., 2015, 5, 94776-94785; (c) B. Karimi, S. Abedi, J. H. Clark and V. Budarin, Angew. Chem. Int. Ed., 2006, 45, 4776-4779; (d) S. Shi and Y. Zhang, Green Chem., 2008, 10, 868-872.
- 5 (a) K. V. Bukhryakov, C. Mugemana, K. B. Vu and V. O. Rodionov, Org. Lett., 2015, 17, 4826-4829; (b) Q. H. Fan, C. Y. Ren, C. H. Yeung, W. H. Hu and A. S. C. Chan, J. Am. Chem. Soc., 1999, 121, 7407-7408; (c) N. Jiao, Z. Li, Y. Wang, J. Liu and C. Xia, RSC Adv., 2015, 5, 26913-26922.
- 6 K. Gude and R. Narayanan, J Phys Chem C, 2011, 115, 12716-12725.
- 7 (a) J. Safari and Z. Zarnegar, New J. Chem., 2014, 38, 358-365; (b) H. Yang, Y. Wang, Y. Qin, Y. Chong, Q. Yang, G. Li, L. Zhang and W. Li, Green Chem., 2011, 13, 1352; (c) P. B. Yang, R. Ma and F. L. Bian, ChemCatChem, 2016, 8, 3746-3754; (d) Q. M. Kainz, R. Linhardt, R. N. Grass, G. Vilé, J. Pérez-Ramírez, W. J. Stark and O. Reiser, Adv. Funct. Mater., 2014, 24, 2020-2027.
- (a)W. Dong, L. Zhang, C. Wang, C. Feng, N. Shang, S. Gao and 8 C. Wang, RSC Adv., 2016, 6, 37118-37123; (b)A. Arnanz, M. Pintado-Sierra, A. Corma, M. Iglesias and F. Sánchez, Adv. Synth. Catal., 2012, 354, 1347-1355.
- 9 D. Wang and D. Astruc, Chem. Rev., 2014, 114, 6949-6985.
- 10 (a) Y. Gu and G. Li, Adv. Synth. Catal., 2009, 351, 817-847; (b) C. Van Doorslaer, J. Wahlen, P. Mertens, K. Binnemans and D. De Vos, Dalton Trans., 2010, 39, 8377-8390; (c) F. Giacalone and M. Gruttadauria, ChemCatChem, 2016, 8, 664-684
- 11 (a) M. I. Burguete, E. García-Verdugo, I. Garcia-Villar, F. Gelat, P. Licence, S. V. Luis and V. Sans, J. Catal., 2010, 269, 150-160; (b) P. Agrigento, S. M. Al-Amsyar, B. Soree, M. Taherimehr, M. Gruttadauria, C. Aprile and P. P. Pescarmona, Catal. Sci. Technol., 2014, 4, 1598-1607; (c) J. Y. Shin, B. S.

Lee, Y. Jung, S. J. Kim and S. G. Lee, Chem Commun, 2007, 0, 5238-5240; (d) C. Pavia, E. Ballerini, L. A. Bivona, F. Giacalone, C. Aprile, L. Vaccaro and M. Gruttadauria, Adv. Synth. Catal., 2013, 355, 2007-2018.; (e) E. Tyrrell, L. Whiteman and N. Williams, J. Organomet. Chem., 2011, 696, 3465-3472; (f) V. Kozell, M. McLaughlin, G. Strappaveccia, S. Santoro, L. A. Bivona, C. Aprile, M. Gruttadauria and L. Vaccaro, ACS Sustainable Chem. Eng., 2016, 4, 7209-7216; (g) M. Buaki-Sogó, A. Vivian, L. A. Bivona, H. García, M. Gruttadauria and C. Aprile, Catal. Sci. Technol., 2016, 6, 8418-8427.

- 12 (a) J. Restrepo, P. Lozano, M. I. Burguete, E. García-Verdugo and S. V. Luis, Catal. Today, 2015, 255, 97-101; (b) V. Sans, F. Gelat, N. Karbass, M. I. Burguete, E. García-Verdugo and S. V. Luis, Adv. Synth. Catal., 2010, 352, 3013-3021.
- 13 A. Ying, S. Liu, Z. Li, G. Chen, J. Yang, H. Yan and S. Xu, Adv. Synth. Catal., 2016, 358, 2116-2125.
- 14 (a) S. G. Lee, Chem Commun, 2006, 0, 1049-1063; (b) L. Qiao, X. Shi, X. Lu and G. Xu, J. Chromatogr. A, 2015, 1396, 62-71.
- 15 B. Karimi, F. Mansouri and H. Vali, Green Chem., 2014, 16, 2587.
- 16 (a) M. H. Valkenberg, C. deCastro and W. F. Holderich, Green Chem., 2002, 4, 88-93; (b) T. Sasaki, C. Zhong, M. Tada and Y. Iwasawa, Chem Commun, 2005, 0, 2506-2508; (c) A. E. Wendlandt, A. M. Suess and S. S. Stahl, Angew. Chem. Int. Ed., 2011, 50, 11062-11087.
- 17 (a) L. Fu, G. Lai, D. Zhu, B. Jia, F. Malherbe and A. Yu, ChemCatChem, 2016, 8, 2975-2980; (b) S. Sabater, J. A. Mata and E. Peris, Organometallics, 2015, 34, 1186-1190; (c) S. Sabater, J. A. Mata and E. Peris, ACS Catal., 2014, 4, 2038-2047; (d) H. Yang, Y. Kwon, T. Kwon, H. Lee and B. J. Kim, Small, 2012, 8, 3161-3168.
- 18 (a) A. Shaygan Nia, S. Rana, D. Dohler, F. Jirsa, A. Meister, L. Guadagno, E. Koslowski, M. Bron and W. H. Binder, Chemistry, 2015, 21, 10763-10770; (b) Z. Li, W. Zhang, Q. Zhao, H. Gu, Y. Li, G. Zhang, F. Zhang and X. Fan, ACS Sustainable Chem. Eng., 2015, 3, 468-474; (c) S. K. Movahed, N. F. Lehi and M. Dabiri, RSC Adv., 2014, 4, 42155-42158; (d) Q. S. Zhao, D. F. Chen, Y. Li, G. L. Zhang, F. B. Zhang and X. B. Fan, Nanoscale, 2013, 5, 882-885; (e) D. R. Dreyer, S. Park, C. W. Bielawski and R. S. Ruoff, Chem. Soc. Rev., 2010, 39, 228-240; (f) S. Sun, Y. Cao, J. Feng and P. Wu, J. Mater. Chem., 2010, 20, 5605-5607.
- 19 (a) S. Doherty, J. G. Knight, T. Backhouse, E. Abood, H. Alshaikh, I. J. S. Fairlamb, R. A. Bourne, T. W. Chamberlain and R. Stones, Green Chem., 2017, 19, 1635-1641; (b) E. Sin, S. S. Yi and Y. S. Lee, J Mol Catal a-Chem, 2010, 315, 99-104; (c) J. F. Soule, H. Miyamura and S. Kobayashi, J. Am. Chem. Soc., 2013, 135, 10602-10605.
- 20 M. J. Fernandez-Merino, L. Guardia, J. I. Paredes, S. Villar-Rodil, P. Solis-Fernandez, A. Martinez-Alonso and J. M. D. Tascon, J Phys Chem C, 2010, 114, 6426-6432.
- 21 Z. Wang, Z. Ge, X. Zheng, N. Chen, C. Peng, C. Fan and Q. Huang, Nanoscale, 2012, 4, 394-399.
- 22 C. C. Cassol, A. P. Umpierre, G. Machado, S. I. Wolke and J. Dupont, J. Am. Chem. Soc., 2005, 127, 3298-3299.
- 23 (a) S. K. Movahed, R. Esmatpoursalmani and A. Bazgir, RSC Adv., 2014, 4, 14586-14591. (b) N. Shang, S. Gao, C. Feng, H. Zhang, C. Wang and Z. Wang, RSC Adv., 2013, 3, 21863-21868. (c) J.H. Park, F. Raza, S.-J. Jeon, H.-I. Kim, T. W. Kang, D. Yim and J.-H. Kim. Tetrahedron Lett., 2014. 55, 3426-3430. (d) H. Yang, X. Han, G. Li and Y. Wang, Green Chemistry, 2009, **11**, 1184-1193.

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Pd supported on ionic liquids functionalized RGO was fabricated and the catalyst shown excellent performance for Suzuki- Miyaura coupling reaction.