Key factors in adhesion process between graphene and polymers

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Graphene presents outstanding properties that have opened new avenues of research for a variety of applications in many fields [1]. However, since its atomic thickness, it must be bound to at least one substrate for most of applications [2]. The manufacturing of flexible devices or special coating materials with suitable design and performance is totally related to an efficient adhesion process involving polymers such as two-dimensional material, for instance, the graphene produced by chemical vapor deposition [3]. In this work, for the first time, we performed static contact angle (CA) measurements of four distinct polymers (LDPE – low density polyethylene, PP – polypropylene, PBAT - poly (butylene adipate-co-terephthalate) and PVDF-TrFE poly(vinylidene-fluoride-co-trifluorethylene)) and CVD graphene at specific thermal conditions to better understand adhesion phenomena occurred during transfer processes at high temperatures, such as in the Direct Dry Transfer (DDT)[4]. Surface analysis allowed us to pre-estimate the efficiency of the transfer method owing to understanding the properties of polymer surfaces and CVD graphene regarding adhesion, by comparing their polar and dispersive components, which compound surface free energy. However, rheological properties and chemical structures seemed to be equally important in this evaluation, since by varying molecular weight of polymers, the adhesion and the efficiency of graphene transfer to such substrates were altered. The results allowed us to comprehend the role of the major factors in adhesion phenomena and how it can be used to improve graphene coating onto polymeric surfaces in transfer processes performed at high temperatures.

References

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[2] Kozbial, A. et al., Langmuir, 30 (2014), 8598.
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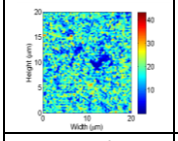
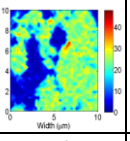
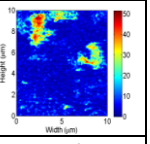
Figures

LDPE	PP	PBAT	PVDF-TrFE
	No signal detected		
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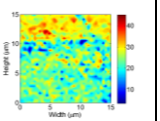
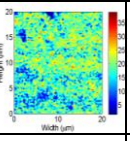
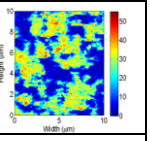
	No signal detected		
90%	0%	85%	40%

Figure 1: 2D band FWHM Raman mapping and the correspondent percentage of CVD graphene coating onto polymer surfaces (LDPE, PP, PBAT and PVDF-TrFE) analysed. Top line results are referent to neat and those in bottom line are from molecular weight modified polymers.

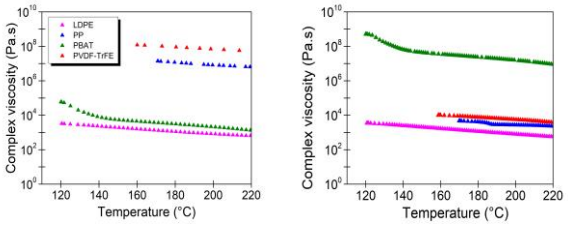


Figure 2: Complex viscosity rheological curves achieved for (a) neat and (b) molecular weight modified polymers.