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Vertically oriented graphene based walls and columns obtained by ICP CVD method on moving substrates as prior stage of the roll-to-roll technology

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1. Introduction

Superior optoelectronic properties of graphene have made this material as a special applicant in displays, touch and graphene-based screens with smaller and long-lasting batteries including the field of mobile telephony [1]. Recently we have introduced the process for the formation of vertically oriented graphene (VOG) walls with a curved morphology by ICP CVD method [2]. Such VOG walls represent a very promising material for different applications (e.g. miniature batteries and other optoelectronic devices) due to its unique orientation and open carbon network structure. For the first time such VOG walls have been grown directly on a moving substrate that is a prerequisite for its production by the roll-to-roll technology providing higher yield of the production process at lower cost of the product.

2. Experimental part

Here we present recent results in the continuation of [2]. New vertically oriented graphene based walls and columns were formed by the ICP CVD apparatus, manufactured by IZOVAC Technologies Ltd. (Minsk, Belarus) with the moving substrate, simulating the roll-to-roll process. Such technological parameters as propane/argon partial pressure, duration of deposition (min), heating time (min) and temperature (< 500°C) of a moving substrate were examined in the use of this method.

3. Results and Discussion

VOG morphology and thickness depends on the technological parameters of the process. SEM images reveal two distinct VOG coatings obtained on a moving copper or Al_2O_3 substrates (Figure 1A and B). In Figure 1A VOG coating was prepared at 2/5 propane partial pressure, 5 min of deposition time and at 450°C of a moving copper foil substrate. This coating is composed of curved VOG walls with a height of ~40 nm and the thickness below ~17 nm. In contrast, in Figure 1B and D vertically oriented graphene based columns with a height of ~5 μm and ~230 nm diameter were produced on a moving Al_2O_3 substrate (4/5 propane partial pressure, 225 min of deposition time at 400°C). Both materials exhibit characteristic Raman peaks of graphene based materials (Figure 1C).

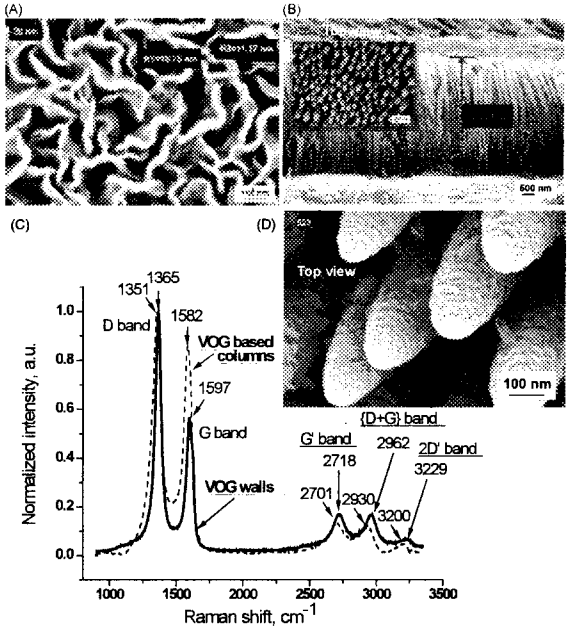

Figure1: Representative SEM images of two types of coatings: (A) thin vertically oriented graphene (VOG) walls produced on a moving copper foil substrate; (B) and (D) thick vertically oriented graphene based columns prepared on a moving Al_2O_3 substrate in the use of ICP CVD apparatus, manufactured by IZOVAC Technologies Ltd. (Minsk, Belarus). (C) Raman spectra of these two types of VOG based materials (λ_{exc} = 473 nm)

4. Conclusions

VOG based wall and columns can be produced by the ICP CVD method on a moving substrate, simulating the roll-to-roll technology.

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6. References

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