One-Step Salt-Assisted Deposition of Carbon Material onto the Polymer Substrate

Nikolay Dementev

13 Sportivnaya Street, Orlovka, Hohol Area,
Voronezh Region, 396836, Russia

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KEYWORDS: carbon material, deposition, polymer substrate, graphene, carbon nanotubes

Introduction

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Experimental section

Materials

Overhead projector polyester transparency films OHP-10C, A4 format, 100 micrometer thick were purchased from COOP University store, Japan (Fig. 1), cut on 60 mm x 60 mm pieces, labeled, and used without any pretreatment in the experiments. Water-based black ink produced and purchased in Russia (Fig. 2). Additives free table salt (i.e. sodium chloride, NaCl).

Characterization

Optical microscopy of the films was performed on Do-Nature STV-451M digital microscope, Kenko, Japan

Experimental procedure

1. Attach metal needle to a brand-new empty 2 mL medical syringe.
2. Remove plunger from the syringe. Put ~ 0.2 mL of table salt into the syringe. Put the plunger back.
3. Fill the syringe through the needle with ~ 2 mL of the ink.
4. Leave the syringe with the ink in ~ 45° to normal position for ~ 1 hour.
5. Put 15 drops of the syringe' content onto the polymer substrate (60 mm x 60 mm piece of a polyester film). Put another polymer film on the top of the first one. Wait for 1 minute.
6. Detach the films from each other and rinse them under the stream of cold (~ + 15°C) tap water.
7. Dry the films by intense shaking.

Control experiments were run following the same procedure, except the step 2 was skipped (i.e. no NaCl in control experiments was used).

Results and discussion

Naked eye visual observation clearly shows that no distinct deposition happens after the contact of polyester films with pristine (i.e. without NaCl) ink (Fig. 3). On the other hand, ink with the addition of the table salt, does form distinct deposits on polyester films after the 1 min. contacts with them (Fig. 4). Microscopic images near the edges of deposits demonstrate that the deposits are even and uniform and presented not only with microscopically resolved agglomerates, but also with the objects that are beyond the resolution limit of microscope (Fig. 5,6). The observation gives basis for experimenting with much smaller objects than the carbon particles in the ink, such as carbon nanotubes or graphene [1,2]. No crystals of NaCl were observed in deposits, meaning that the rinsing was successful in removing the salt and, probably, that the salt plays only a role of mediator in the initial step of the deposit formation.

Concluding remarks

It is worth noting that the deposit formation in the presence of the salt was successful only in the days when relative humidity of the air was not higher than ~10%. Author hopes that the approach will succeed in deposition of graphene on polymer substrates, thus alleviating the search for a proper replacement of indium tin oxide in the production of transparent electrodes.

References

1. Grobert, N., *Carbon nanotubes - becoming clean.*, Materials Today, 2006, 10, (1-2), 28-35.

2. Geim, A. K., Novoselov, K. S., *The rise of graphene.,* Nature Materials, 2007, 6, (3), 183-191

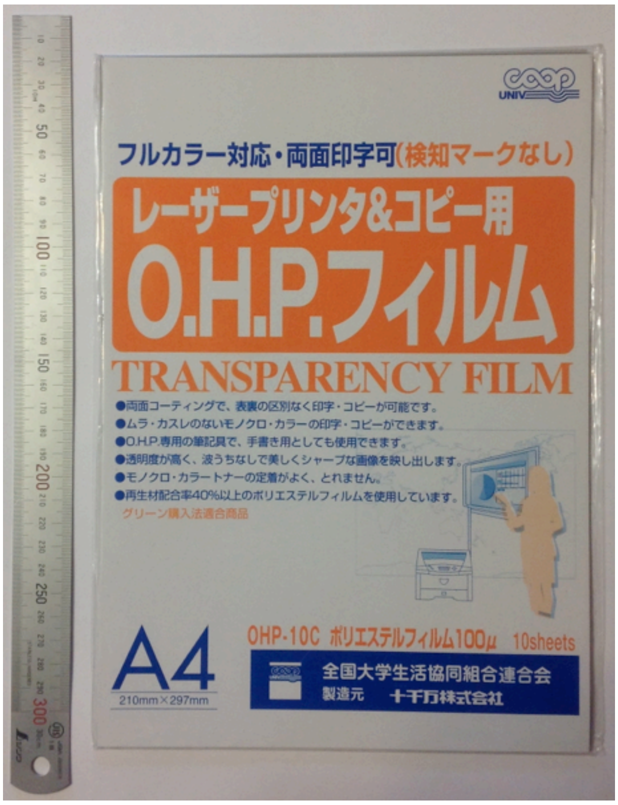

Figure 1. Cover bag of the original polyester films.

Figure 2. Bottle of the ink.

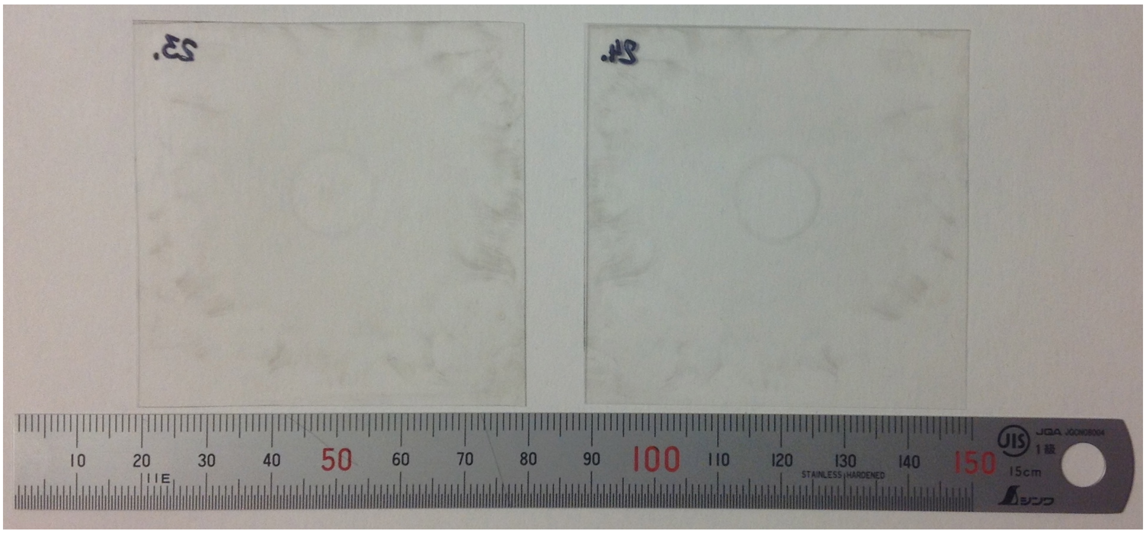

Figure 3. Polyester films (labeled as "23" and "24") after the control experiment (i.e. after the contact with pristine ink; no table salt in the ink).

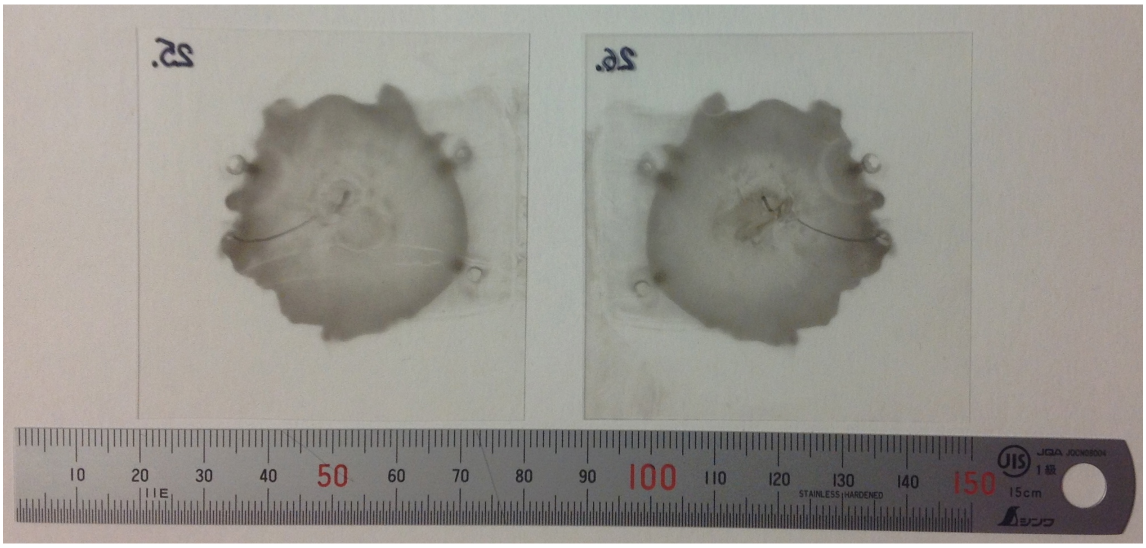

Figure 4. Polyester films (labeled as "25" and "26") after the experiment (i.e. after the contact with ink, which contains table salt).

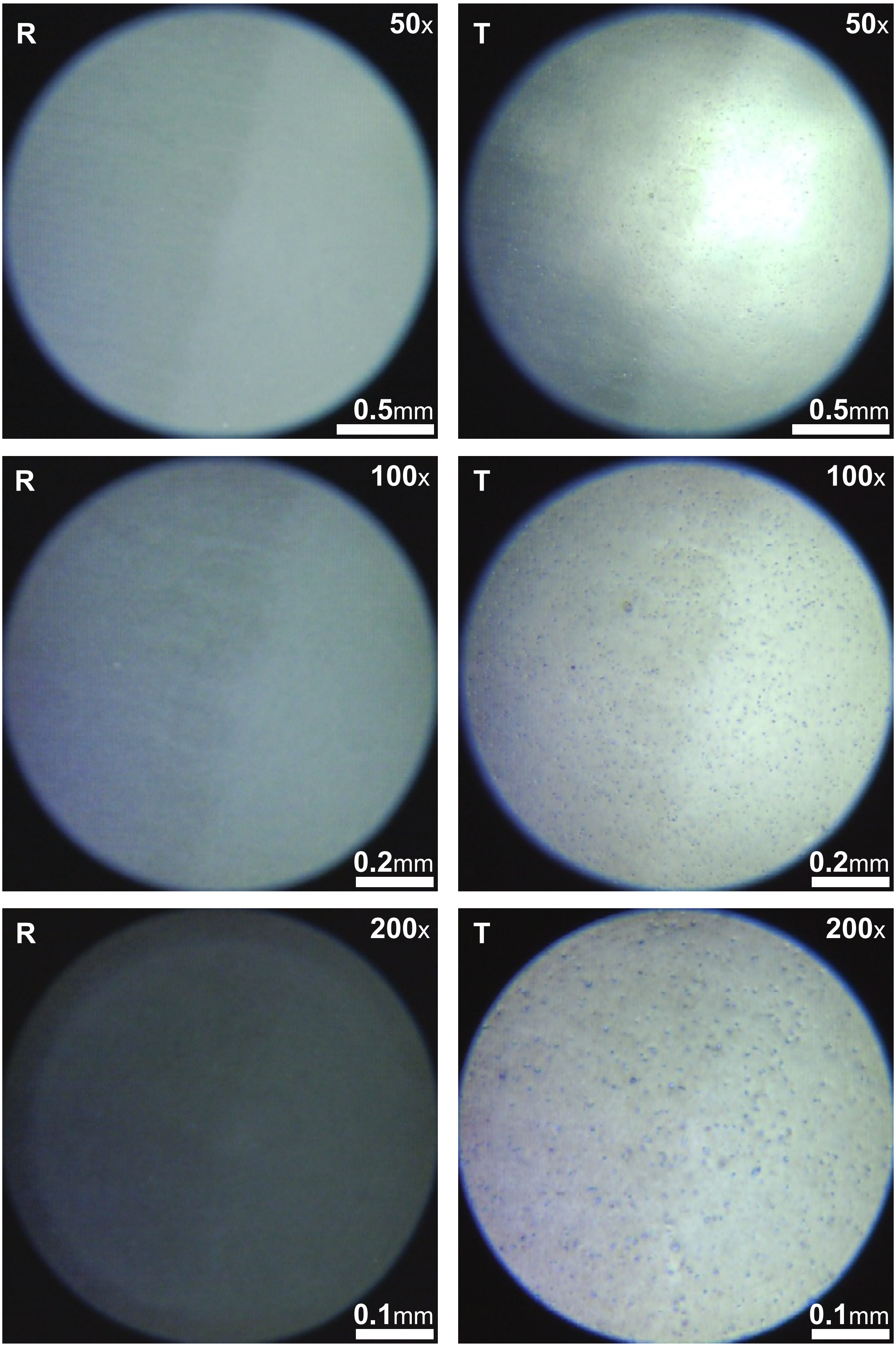

Figure 5. Microscopic images of polyester film (labeled as “25”) near the edge of the deposit. “R” stands for Reflection mode; “T” stands for Transmission mode.

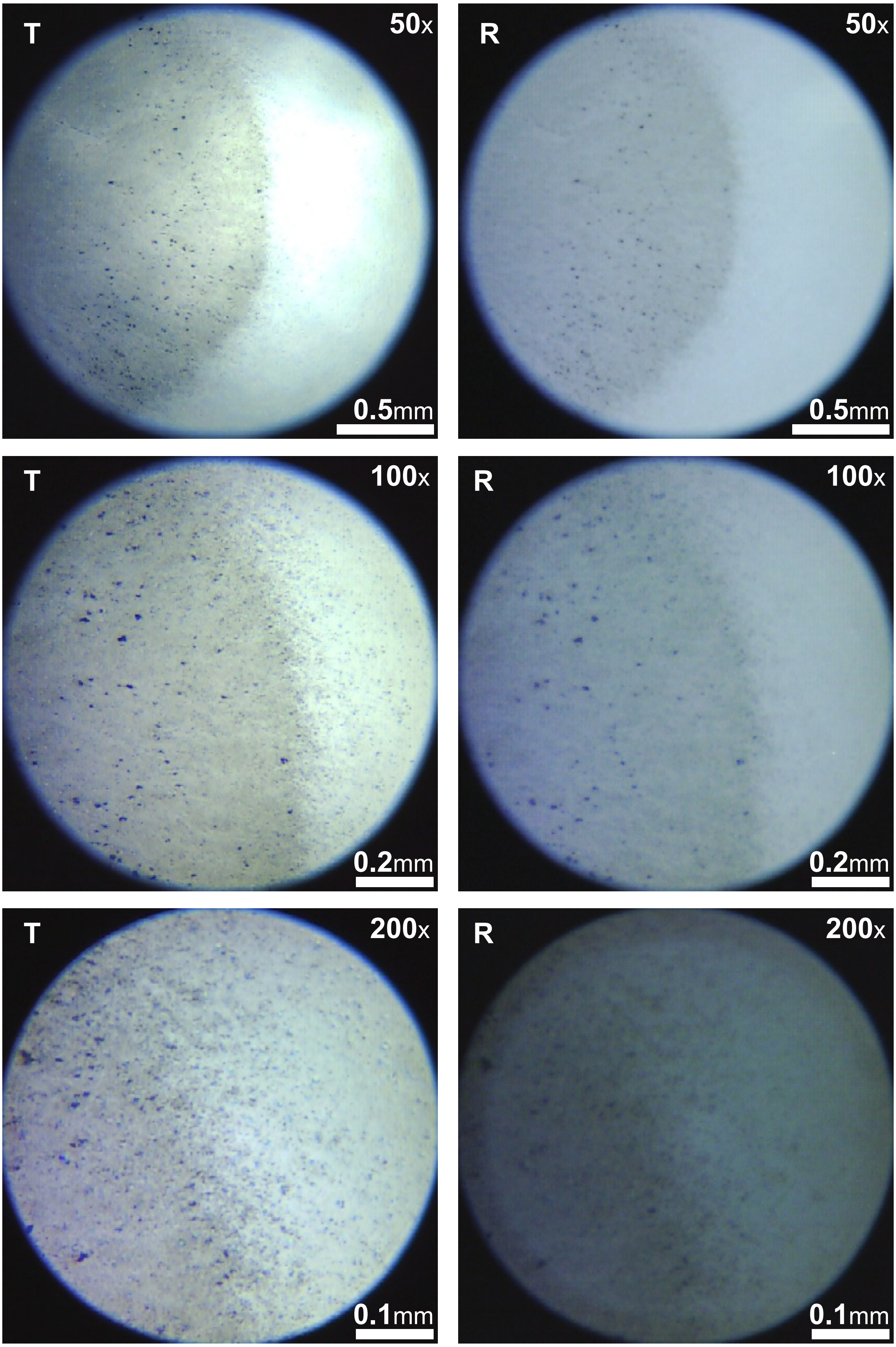

Figure 6. Microscopic images of polyester film (labeled as “26”) near the edge of the deposit. “R” stands for Reflection mode; “T” stands for Transmission mode.