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บันทึกข้อความ

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ที่ วคบ. **วันที่**

เรื่อง โปรดลงนาม

เรียน คณบดีคณะวิศวกรรมศาสตร์ (ผ่านรองคณบดีฝ่ายวิชาการ)

ตามที่ภาควิชาวิศวกรรมเคมี ได้จัดสอบวิทยานิพนธ์นิสิตบัณฑิตศึกษา ของนิสิตชื่อ นาย ขวัญพงศ์ เหมือนโพธิ์ เลขประจำตัว 4770229721 ระดับปริญญาโท ในหัวข้อวิทยานิพนธ์ เรื่อง “การสร้างฟิล์มบางของอนุภาคนาโนของทองบนพอลิอิไมด์” ซึ่งผลการสอบที่ได้ ดีมาก

ภาควิชาวิศวกรรมเคมี ขอส่งวิทยานิพนธ์ฉบับสมบูรณ์ จำนวน 1 ชุด เพื่อโปรดให้ท่านคณบดีลงนามตามเอกสารที่แนบมา

จึงเรียนมาเพื่อโปรดลงนามในวิทยานิพนธ์ฉบับสมบูรณ์ดังกล่าวด้วย จักขอบคุณยิ่ง

(ศาสตราจารย์ ดร.ปิยะสาร ประเสริฐธรรม)
หัวหน้าภาควิชาวิศวกรรมเคมี

APPENDIX A

Calculation of Percent Coverage of Gold Nanoparticles on Substrate

We can calculate the percent coverage of AuNPs on modified surfaces from the following equation:

$$\% \text{ Coverage of AuNPs} = \left(\frac{\left(\frac{1}{4} \pi d^2 N \right)}{A} \right) x100$$

Where d is the average diameter of 50 gold nanoparticles (nm)
N is the amount of AuNPs on surface, being 1000x1000 nm^2 in area
A is the total area in surface

Assumption 1. Gold nanoparticle is regular sphere.
2. The differention in AuNPs diameter isn't significant.

Because the standard deviation of AuNPs diameter is small, the average diameter of gold nanoparticle was calculated from the average diameter of 50 gold nanoparticles. The value was then multiplied by the amount of AuNPs on total area to calculate the area covered by gold nanoparticles.

Figure A1 shows the examples of size distribution of gold nanoparticles on the surface area. The size distribution of AuNPs on APTMS-modified glass slide and polyimide are shown in Figure A1(a-b), respectively. The average diameter and standard deviation of gold nanoparticles in APTMS-modified glass slide are 18.84 nm and 1.94, respectively. The average diameter and standard deviation of gold nanoparticles in APTMS-modified polyimide are 28.56 nm and 3.38, respectively. Those standard deviation are small. Therefore, the area of surface covered by AuNPs can be calculated from the average value of 50 gold nanoparticles.

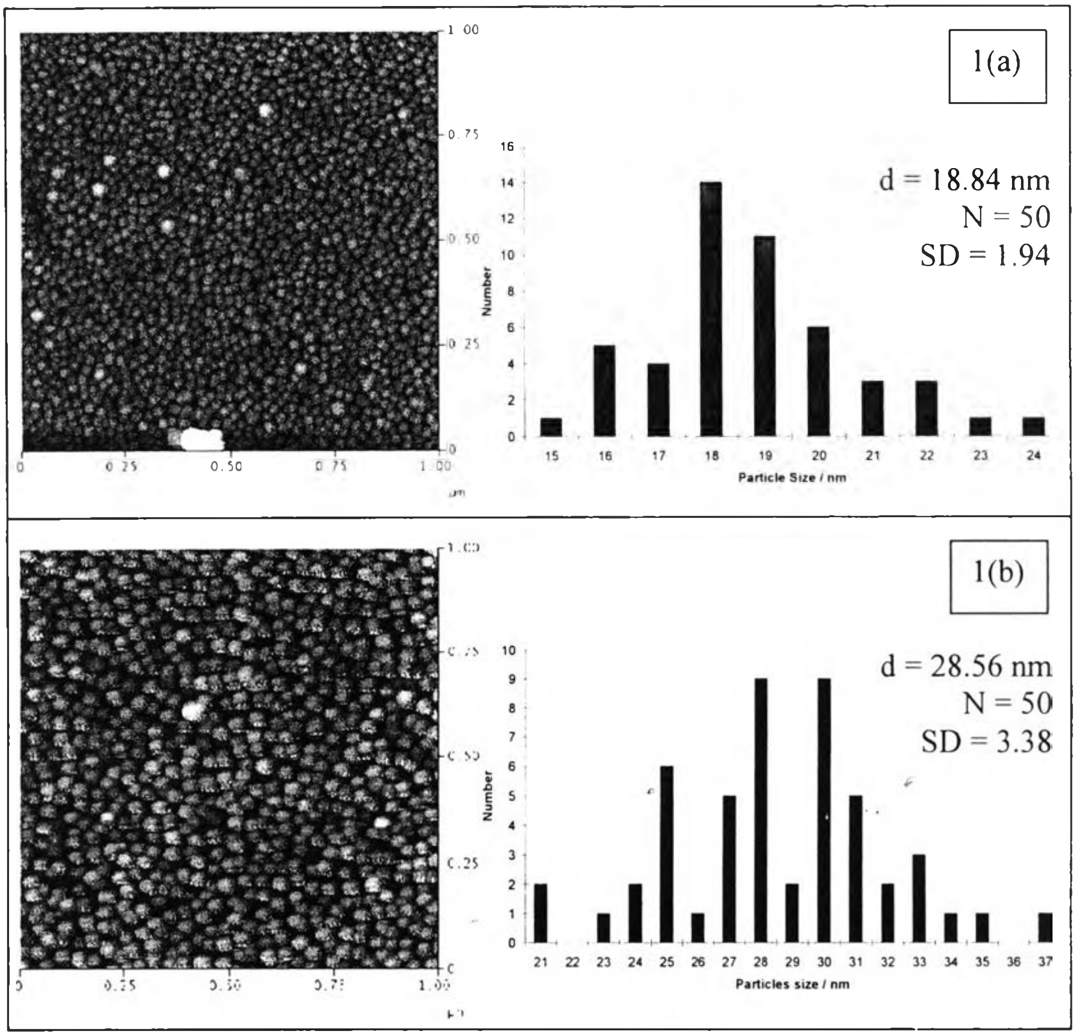


Figure A1 size distribution of gold nanoparticles on various : (a) APTMS-modified glass slide and (b) APTMS-modified polyimide

Calculation exemple for the percent AuNPs coverage on APTMS-modified glass

Diameter (nm)	15	16	17	18	19	20	21	22	23	24
Number	1	5	4	14	11	6	3	3	1	1

Calculating the average diameter

$$d = \frac{(15x1)+(16x5)+(17x4)+(18x14)+(19x11)+(20x6)+(21x3)+(22x3)+(23x1)+(24x1)}{50}$$

$= 18.84$

$\therefore$ The average diameter is 18.84 nm. (d = 18.84)

Counting the number of AuNPs on surface

The total number of AuNPs on 1000x1000 nm^2 of APTMS-modified glass, is 1373 nanoparticles. (N = 1373)

Determination of the total area

Because scan size of AFM is 1 μm, the total area is 1000x1000 = 10^6 nm^2 (A = 10^6)

These values are substitute in

$$\% \text{ Coverage of AuNPs} = \left(\frac{\left(\frac{1}{4} \pi d^2 N \right)}{A} \right) x100$$

$$= \left(\frac{\left(\frac{1}{4} \pi (18.84)^2 (1373) \right)}{10^6} \right) x100$$

$$= 38.26$$

∴ The percent coverage of AuNPs on APTMS-modified glass slide is 38.26

APPENDIX B

Standard Test Method for Measuring Adhesion by Tape Test

(Destination: D 3359 - 02)

1. Scope

1.1 These test methods cover procedures for assessing the adhesion of coating films to metallic substrates by applying and removing pressure-sensitive tape over cuts made in the film.

1.2 Test Method A is primarily intended for use at job sites while Test Method B is more suitable for use in the laboratory. Also, Test Method B is not considered suitable for films thicker than 5 mils (125μm).

1.3 These test methods are used to establish whether the adhesion of a coating to a substrate is at a generally adequate level. They do not distinguish between higher levels of adhesion for which more sophisticated methods of measurement are required.

1.4 In multicoated systems adhesion failure may occur between coats so that the adhesion of the coating system to the substrate is not determined.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

2. Summary of Test Method

2.1 ***Test Method A*** -An X-cut is made through the film to the substrate, pressure-sensitive tape is applied over the cut and then removed, and adhesion is assessed qualitatively on the 0 to 5 scale.

2.2 ***Test Method B*** – A lattice pattern with either six or eleven cuts in each direction is made in the film to the substrate, pressure-sensitive tape is applied over the lattice and then removed and adhesion is evaluated by comparison with descriptions and illustrations.

Test Method B – Cross-Cut Tape Test

Procedures

1. Select an area free of blemishes and minor surface imperfections, place on a firm base, and under the illuminated magnifier, make parallel cuts as follows:

1.1 For coating having a dry film thickness between 2.0 mils (50 μm) space the cuts 2 mm apart and make six cuts. For films thicker than 5 mils use Test Method A.

1.2 Make all cuts about 20 mm (3/4 in.) long. Cut through the film to the substrate in one steady motion using just sufficient pressure on the cutting tool to have the cutting edge reach the substrate. When making successive single cuts with the aid of a guide, place the guide on the uncut area.

2. After making the required cuts brush the film lightly with a soft brush or tissue to remove any detached flakes or ribbons of coatings.

3. Examine the cutting edge and, if necessary, remove any flat spots or wire-edge by abrading lightly an a fine oil stone. Make the addition number of cuts at 90° to and centered on the original cuts.

4. Brush the area as before and inspect the incisions for reflection of light from the substrate. If the metal has not been reached make another grid in a different location.

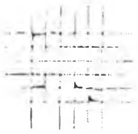
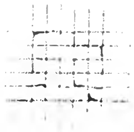
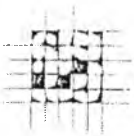
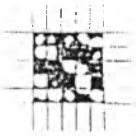
5. Remove two complete laps of tape and discard. Remove an additional length at a steady (that is, not jerked) rate and cut a piece about 75 mm (3 in.) long.

6. Place the center of the tape over the grid and in the area of the grid smooth into place by a finger. To ensure good contact with the film rub the tape firmly with the eraser on the end of a pencil. The color under the tape is a useful indication of when good contact has been made.

7. Within 90 ± 30 s of application, remove the tape by seizing the free end and rapidly (not jerked) back upon itself at as close to an angle of 180° as possible.

8. Inspect the grid area for removal of coating from the substrate of from a previous coating using the illuminated magnifier. Rate the adhesion in accordance with the following scale illustrated in Table B1:

Table B1 Classification of Adhesion Test Results

CLASSIFICATION OF ADHESION TEST RESULTS		
CLASSIFICATION	**PERCENT AREA REMOVED**	**SURFACE OF CROSS-CUT AREA FROM WHICH FLAKING HAS OCCURRED FOR SIX PARALLEL CUTS AND ADHESION RANGE BY PRECENT**
5B	0 % None	
4B	Less than 5 %	
3B	5 - 15 %	 
2B	15 – 35 %	 
1B	35 – 65 %	 
0B	Greater than 65 %	

5B The edges of cuts are completely smooth; none of the squares of the lattice is detached.

4B Small flakes of the coating are detached at intersections; less than 5 % of the area is affected.

3B Small flakes of the coating are detached along edge and at intersection of cuts. The area affected is 5 to 15 % of the lattice.

2B The coating has flaked along the edges and on parts of the squares. The area affected is 15 to 35 % of the lattice.

1B The coating has flaked along the edge of cuts in large ribbons and whole squares have detached. The area affected is 35 to 65 % of the lattice.

0B Flaking and detachment worse than Grade 1.

APPENDIX C

LIST OF PUBLICATION

1. Kwarnpong Muanpho, Piyasan Praserthdam and Varong Pavarajarn. "Surface Modification for Fabrication of Gold Nanoparticles Thin Film on Glass Substrate", 4th Thailand Materials Science and Technology Conference, Bangkok, Thailand, 31 March – 1 April 2005.

VITA

Mr.Kwarnpong Muanpho was born on 21st June, 1982, in Bangkok, Thailand. He received her Bachelor degree of Engineering with a major in Chemical Engineering from Chulalongkorn University, Thailand in April 2004. He continued her Master study in the same major at Chulalongkorn University, Bangkok, Thailand in June 2004.