

## Polymerisation of Aniline on the Butterfly Scale: Bio-Interface Polymerisation

Hiromasa Goto

Division of Materials Science, Faculty of Pure and Applied Sciences,  
University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan

E-mail: gotoh@ims.tsukuba.ac.jp

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**Abstract:** Synthesis of polyaniline on butterfly scale was carried out. Polyaniline emeraldine salt was deposited on the surface of the butterfly scales to form bio/synthetic polymer composite. This research demonstrates bio-interface polymerisation on the butterfly scales.

### Introduction

Small periodic structure of the scales of swallowtail butterfly shows various structural colour. From viewpoints of biomimetics, we have synthesised electroactive polymers in cholesteric liquid crystals exhibiting rainbow [1], turquoise blue [2], and metallic reflection of gold, silver, and bronze [3]. Up to date, we have learned wonderful surface structure of living organisms. Especially, insects, fishes, and shellfishes have unique functional structures.

In this study, polymerisation is performed on butterfly scales as the biological materials. This is another approach against bio-mimetic technology to obtain functional polymer surface because this method directly imprints macroscopic structure from the biological materials. We tentatively refer this method as "bio-interface polymerisation". Resultant polymer is a form of composite with bio-materials and show characteristic structure derived from the bio-material surface.

### Experiment

#### *Butterfly scale*

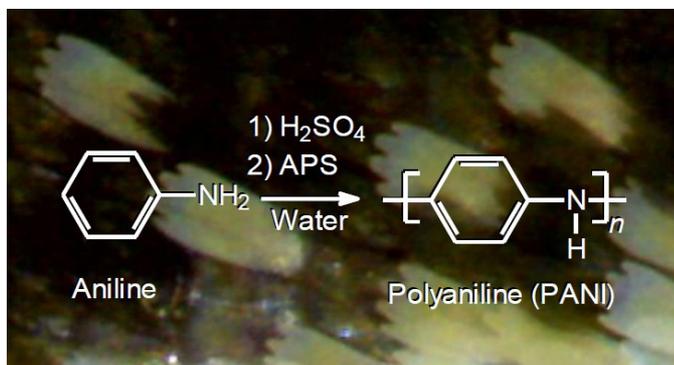
Figure 1 shows optical microscopy image of swallowtail butterfly wing. The surface shows various structural colours derived from fine periodic structure of the scales.



**Figure 1.** Optical micrographs of a swallowtail butterfly wing.

### *Polymerisation on the butterfly scales*

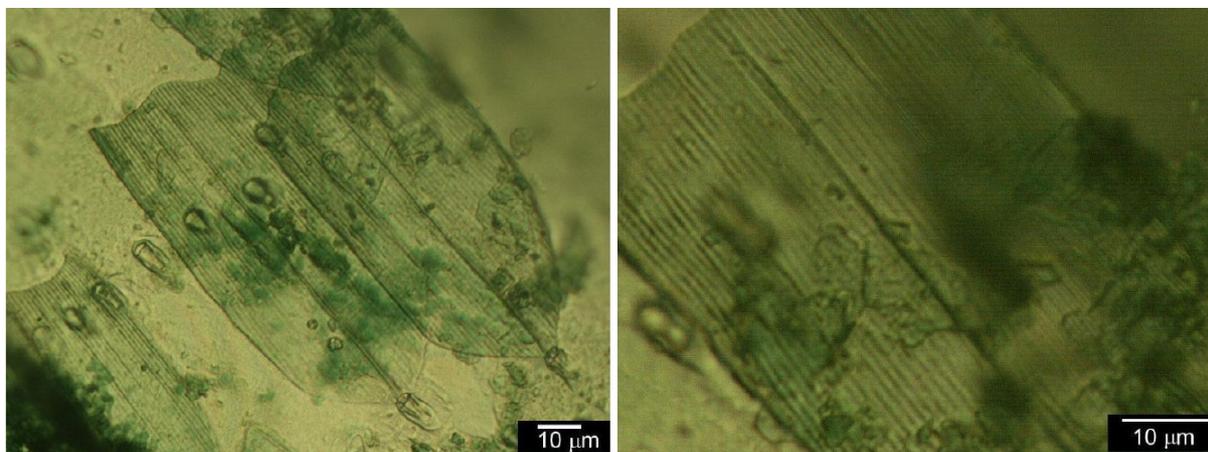
Polymerisation of aniline as a monomer was carried out in a vessel containing ammonium persulfate (APS, oxidiser), sulfuric acid, butterfly scales, and water as a polymerisation solvent (Scheme 1). After reaction for 24h, the reaction mixture was poured into large volume of water followed by filtration. The crude product was further washed with large volume of methanol. Filtration followed by dry under vacuum afford polyaniline/butterfly scale composite.



**Scheme 1.** Synthesis of polyaniline (PANI) on the butterfly scale. Background: A photograph of swallowtail scales. APS = ammonium persulfate.

### *Optical image*

Figure 2 shows optical microscopy images of the resultant bio/synthetic polymer composite. Polyaniline precisely coats the scales. In this case polyaniline is doped form because as prepared form of polyaniline is doped with oxidizer during polymerisation process. In other word, polyaniline emeraldine salt form is deposited on the surface of the scales.



**Figure 2.** Surface image of butterfly scale/polyaniline (bio/synthetic) composite. (Left): 500 x, (Right): 1000 x.

### **Conclusions**

Synthesis of conductive polymer polyaniline was successfully carried out on the surface of the butterfly scales. The composite thus prepared shows fine lines in microscopic level. Preparation of micro-thin line generally requires top-down method by using focused ion beam (FIB) or photolithography with high technology. Polymerisation in liquid crystals also allow to produce thin lines as a bottom up method [1]. As a new approach, the bio-interface polymerisation conveniently produces fine structure of conducting polymer.

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**References**

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