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

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

Introduction

Small perodic structure of the scales of swallowtail butyterfly 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 bronz [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 an another approach against bio-mimetic technology to obtain functional polymer surface because this method directly imprints macroscopic structure from the biological materilas. 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 butyterfly wing. The surface shows various structural colours derived from fine periodic structure of the scales.

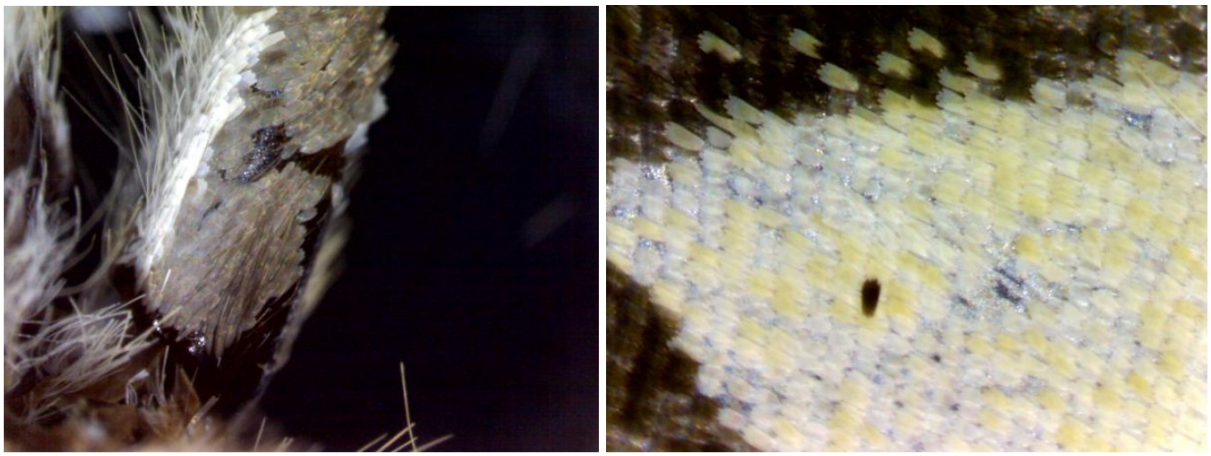
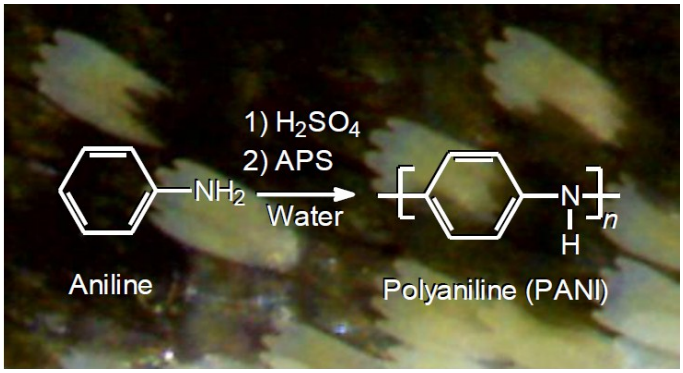


Figure 1. Optical micrographs of a swallowtail butyterfly wing.

Polymerisation on the butterfly scales

Polymerisation of aniline as a monomer was carried out in a vessel containing ammonuim 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 followd by filtration. The crude product was further washed with large volume of methanol. Filtration followed by dry under vaccume afford polyaniline/butterfly scale composite.



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

Optical image

Figure 2 shows optical microscopy images of the resultant bio/syntheic polymer composite. Polyaniline precicely 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.

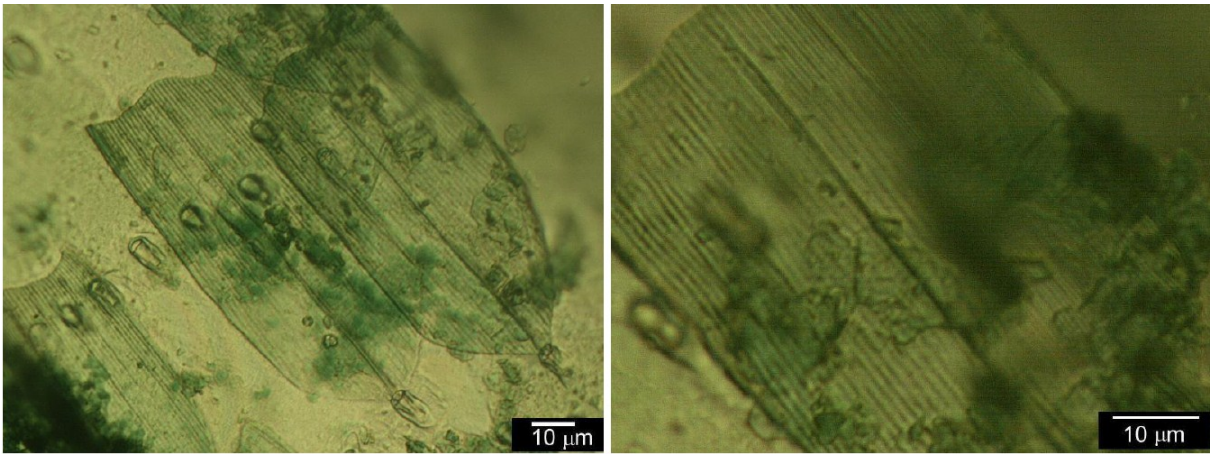


Figure 2. Surface image of butterfly scale/polyaniline (bio/synthetic) composite. (Left): 500 x, (Right): 1000 x.

Conclusions

Synthesis of conductive polymer polyaniline was succesfully 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 forced ion beam (FIB) or photolihography 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.

References

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