Photolithography Process of Organic Thin Film with A New Water Soluble Photoresist

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Abstract

We developed a new photoresist which was composed of polyaniline, uv-curing agent, N-methyl-2-pyrrolidine (NMP) and N-Butyl alcohol (BuOH) as solution. The photoresist is characterized by the capability of being developed in water. We successfully patterned pentacene thin film, which was vulnerable to organic solvent and thus could not be patterned by the conventional photolithography process, with the water soluble photoresist and the minimum feature size was found to be 2um.

1. Introduction

Recently, organic devices which use organic materials for the active layer are attracting much attention because of their noble applications such as flexible display, smart card and ID tags.

At the present micro-patterning of organic thin film is a hot issue. Since organic materials are vulnerable to organic solvent, organic thin film can not be patterned by the conventional photolithography process which uses organic solvent during the process. The various patterning process were proposed such as contact printing which is limited by the minimum feature size.

In this paper we developed a new photoresist which was composed of polyaniline, uv-curing agent, N-methyl-2-pyrrolidine (NMP) and N-Butyl alcohol (BuOH) as solution. We successfully patterned pentacene thin film by photolithography process which used the water soluble photoresist.

2. Experimental and result

1. A New Water Soluble Photoresist

The photoresist consisted of polymer and uv-curing agent and solution as summaried in Table 1. The various polymer such as polyaniline, PVA, PEDOT, and polypyrole can be used and we employed polyaniline. For uv-curing agent benzil-dimethyl and pentaerythritol-triacrylate and urethane-acrylate were mixed by the solution of n-methy-2-pyrrollidine and n-butyl alcohol.

UV-exposure initiated uv-curing agents to cross-link the polymers in the photoresist. Thus, the exposed layer was maintained while the non-exposed layer was washed away in water developer. Therefore, it worked as a positive photoresist. What is a peculiar thing of this work is to use a just DI water as the developing solution instead of organic solvent.

Water-Soluble polymer	Mixture	UV-curing agent	Solution
Polyaniline PEDOT Polypyrrole PVA	N-methyl-2-pyrrolidinone(NMP) N-Butyl alcohol(BuOH) Etyl-cellosolve	Benzil dimethyl keta(PhotoInitiator) Pentaerythritol triacrylate(Monomer) Urethane-acrylate(Oligomer)	H2O

Table 1. Used materials

2. Photolithography Process of Pentacene Thin Film

By using the photoresist pentacene thin films were patterned by photolithography process as shown in Fig.1. The process is similar to the conventional photolithography process except the usage of water as developer. Pentacene thin film was deposited by

OMBD on Si wafer. In this step the density of pentacene film is very important. The loosely packed pentacene film was broken in the spin-coating process of photoresist. Therefore, it is important to deposit pentacene thin film with the low growth rate and increase the packing density. Subsequently, the water soluble photoresist was spin coated on the film and uv was exposed to the photoresist. The exposed film was rinsed by water developer. The opened pentacene layer was etched by O2 plasma and then the final patterns were obtained as shown in Fig.2. As shown in FESEM picture of Fig.3 the patterned film provided a very sharp edge. We could obtain the minimum feature size of 2um.

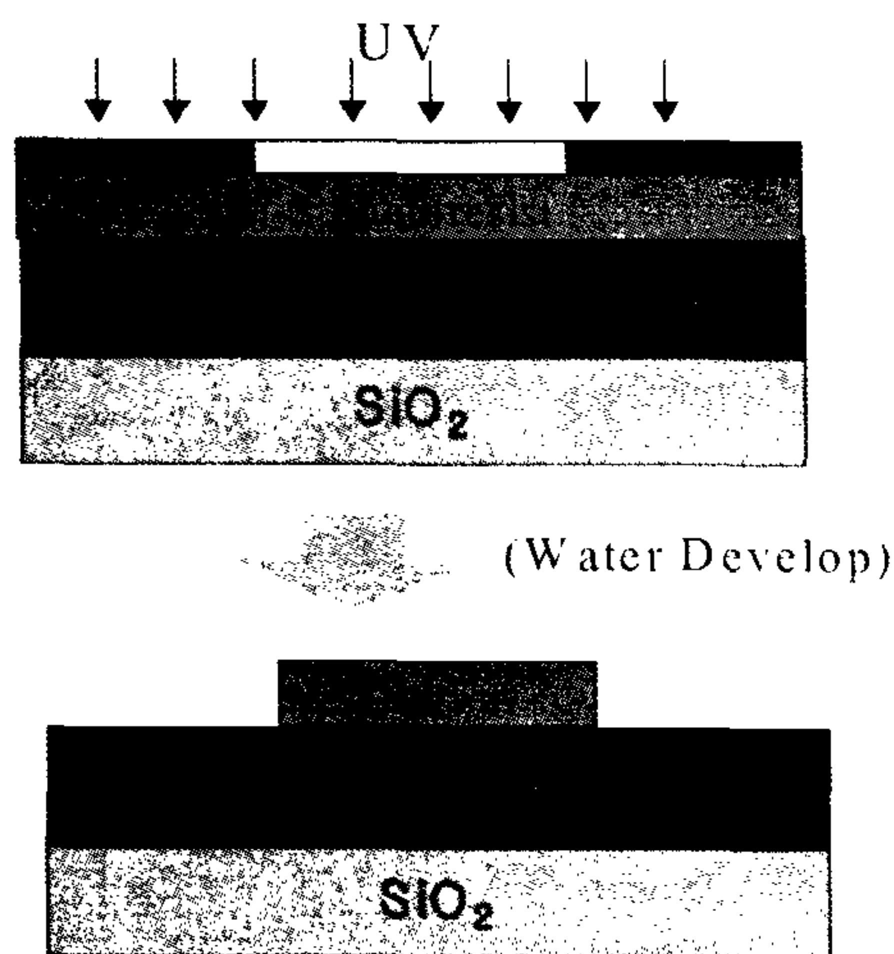

Fig. 1 patterning Process

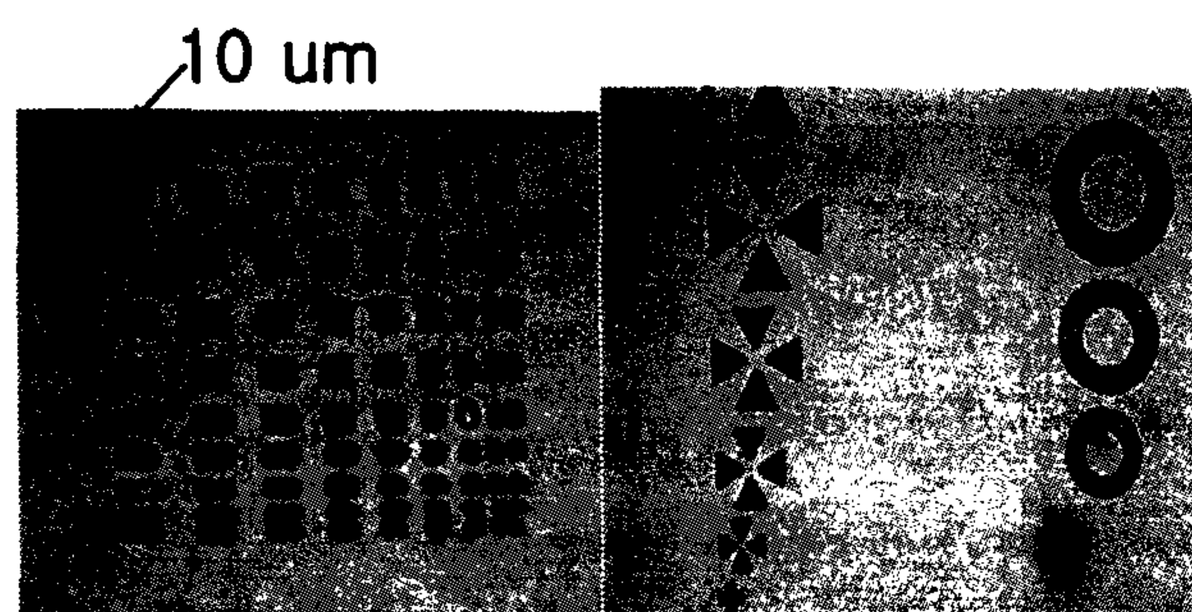

Fig. 2 Optical Microscope picture of patterning pentacene film

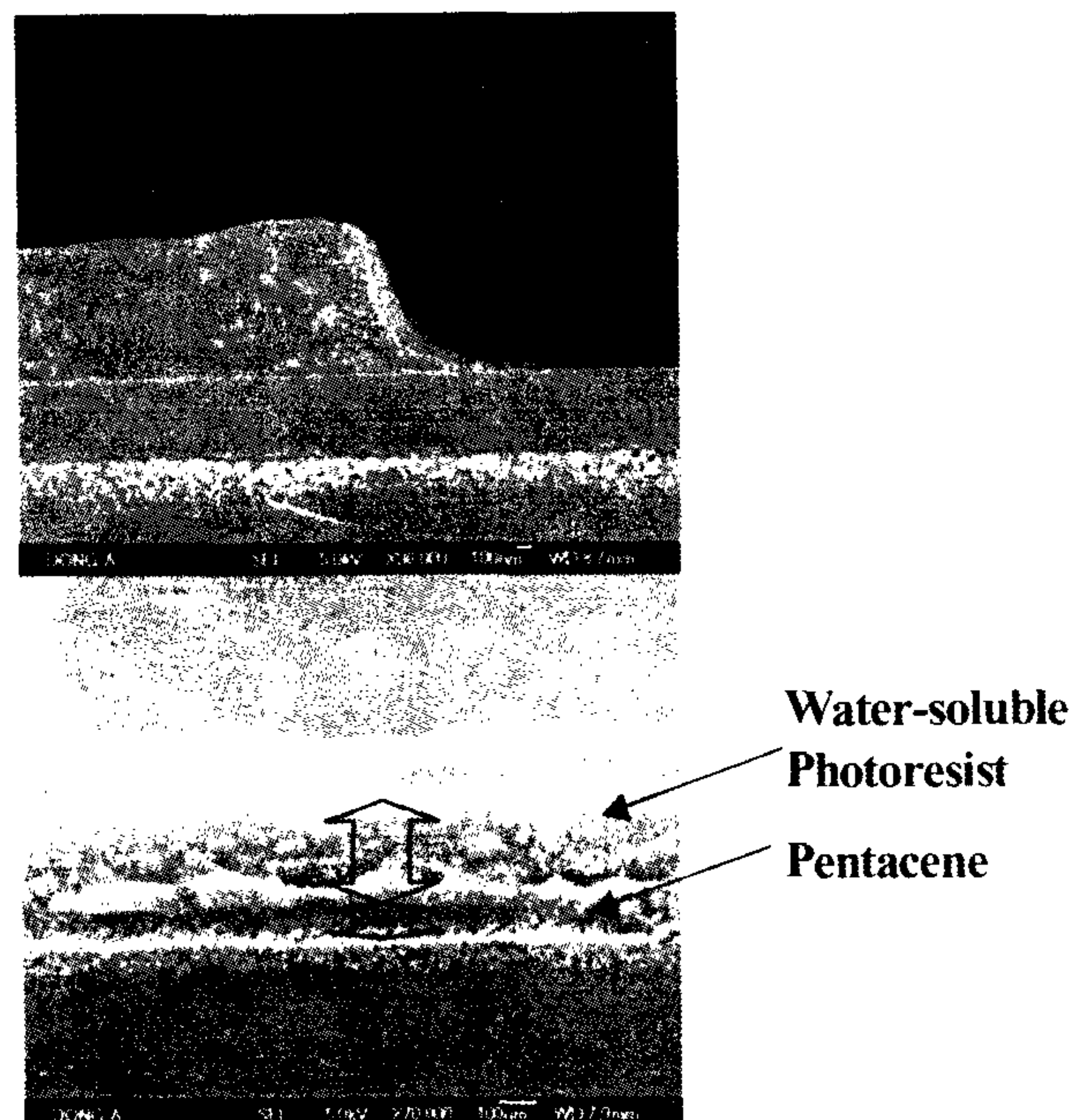

Fig. 3 The FESEM image of pattern

3. Conclusion

We developed a new water soluble photoresist, consisting of polyaniline and uv-curing agent and solution. Especially, the photoresist could be solved in water and thus applied to pattern the organic thin films, which were resistant to water while vulnerable to organic solvent, by photolithography process with the photoresist. We successfully patterened pentacene thin film with the photolithography using the new water soluble photoresist and obtained the minimum feature size of 2um.

5. Acknowledgement

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5. References

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