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## PREPARATION OF SOLVENT DEPENDENT SILVER NANOPARTICLES DOPED PVDF FILMS

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### ABSTRACT

Poly (vinylidene fluoride) (PVDF) is a versatile polymer due to its chemical resistive properties and five different crystalline polymorphs ( $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ , and  $\epsilon$ ). The  $\beta$  crystalline phase is the main focus of interest due to its *all trans* configuration with polar crystalline phase resulting in pyro- and piezo-electric properties which are favorable in electronic application. The typical advantage of PVDF was its chemical inertness, good thermal stability under processing application temperature and good mechanical resistance. Apart from the electronic based applications, PVDF is widely used in different fields, such as pulp and paper industry, nuclear-waste processing applications and chemical industry for chemical and high temperature applications. The preparation of polymorphism control of PVDF by *in-situ* synthesised silver nanoparticles (Ag-NPs) doping is investigated. The Ag-NPs were prepared by simple one step process from  $\text{AgNO}_3$ , where the mixture of N,N-dimethylformamide (DMF) and acetone is utilized as reducing agent as well the solvent of the host polymer, PVDF.

In this work, we also address the suitable technique for correct crystallographic phase identification in PVDF and how the crystallographic phases depending on the solvent. We have prepared silver nanoparticle embedded PVDF films by changing solvent DMF and acetone ratio at particular drying temperature. The prime characterizations were carried out by FT-IR, FE-SEM, and UV-vis absorption.

## ABSTRACT

It was observed that PVDF is one of the best stabilizers of Ag-NPs due to the surface charge and molecular dipole interaction. The Ag-NPs doped PVDF films ( $t \sim 17 \pm 4 \mu\text{m}$ ) were prepared by simple solution casting followed by solvent drying and crystallizing. The formation of piezoelectric polymorph ( $\beta$ -phase) by adequate amount of Ag-NPs doping in PVDF was explained by the specific interaction between the surface charge of the Ag-NPs and dipoles ( $\text{CF}_2$  dipoles) comprising in PVDF.

**Keywords:** PVDF,  $\beta$ -phase, Silver nanoparticle.

## INTRODUCTION

The Poly(vinylidene fluoride) (PVDF) has been extensively studied semi-crystalline material exhibits at least four different crystalline polymorphs referred to as  $\alpha$  (TG TG),  $\beta$  (TTTT),  $\gamma$  ( $\text{T}_3\text{GT}_3\text{G}$ ) and  $\delta$  (polarized a, i.e.,  $a_p$ -phase)-phases, depending on their macromolecular chain conformations of trans (T) and gauge (G) linkages [1]. In order to use PVDF in sensor and actuators fabrication, electroactive crystalline phases, namely  $\beta$  and  $\gamma$  - phases are preferred due to their piezo-, ferro- and pyro-electric properties [2]. Therefore, the  $\beta$  phase has the largest spontaneous polarization per unit cell and thus exhibits the most superior ferroelectric and piezoelectric properties. The  $\gamma$  and  $\delta$  phases are polar but their dipole moment is significantly smaller [3]. Therefore, PVDF containing  $\beta$  phase is a prime interest for electronic applications, i.e. piezoelectric or pyroelectric sensors, microwave transducers as well as non-volatile memories. The as-cast PVDF film is known to predominantly exhibit the  $\alpha$  phase. Over the decades, the research has been focused to induce the  $\beta$  phase in PVDF by several methods like mechanical stretching [4], application of high pressure, melt-quenching, poling under high electric field and tension [5], electrospinning. In this work, the electroactive  $\beta$  phase is induced by silver nanoparticles (Ag NPs) doping in PVDF, The Ag-NPs doped PVDF thin films ( $t \sim 17 \pm 4 \mu\text{m}$ ) were prepared by a solution casting techniques for different Ag-NPs concentrations and the associated properties were investigated by several means. We also address the suitable technique for correct phase identification in PVDF.

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