

Modification of Polypropylene through Intercrosslinking Graft Copolymerization of Poly(vinyl alcohol): Synthesis and Characterization

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ABSTRACT: Modification of polypropylene (PP) has been successfully carried out through intercrosslinking of poly(vinyl alcohol) (PVA), by chemical graft copolymerization method using benzoyl peroxide (BPO) as radical initiator. Prior to grafting, PP was irradiated by gamma rays at a constant dose rate of 3.40 kGy/h to introduce hydroperoxide groups. Optimum conditions pertaining to maximum percentage of grafting were evaluated as a function of different reaction parameters. Maximum percentage of grafting of PVA (75%) was obtained at $[BPO] = 5.51 \times 10^{-2}$ mol/L in 120 min at 70°C using 15 mL of water. Characterization of pristine PP and PP-g-PVA was carried out by FTIR, thermogravimetric analysis, and scanning electron micrography. Swelling studies were carried out in pure, binary, ternary, and quaternary solvent systems com-

prising of water, ethanol (EtOH), dimethylsulfoxide (DMSO) and *N,N*-dimethylformamide (DMF) in different ratios. Maximum swelling values of PP-g-PVA (both composite and true graft) was observed in pure DMSO followed by DMF, EtOH, and water and it was also higher than that observed in mixed solvent system. Water retention studies of pristine PP and PP-g-PVA (both composite and true graft) were investigated at different time periods, temperature, and pH. Maximum % water retention of PP-g-PVA (composite) (108%) was observed in 8 h at 50°C in neutral medium (pH = 7). © 2007 Wiley Periodicals, Inc. *J Appl Polym Sci* 107: 2238–2245, 2008

Key words: polypropylene; poly(vinyl alcohol); graft copolymerization; TGA; swelling and water retention studies

INTRODUCTION

In nonfunctional polymers such as polyethylene and polypropylene (PP), radiation-induced graft copolymerization is an effective method for modification of their chemical and physical properties. Preirradiation leads to the functionalization of the polymer backbone by introducing either hydroperoxide or peroxide groups that serve as the sites for grafting. Extensive work has been reported on modification of these polymers using preirradiation method. Graft copolymerization of styrene onto PP fibers has been studied by simultaneous irradiation method using a 10 MeV electron beam. Samples were irradiated in an environment of N₂ gas.¹ Copolymers of vinylimidazole and acrylic acid have been grafted onto PP films using γ -radiation. The effect of the comonomer composition on the percent graft was also investigated.² Surface modification of PP membranes with hydrophilic 2-hydroxyethyl methacrylate by γ -ray induced graft copolymerization and their solute permeation characteristics were showed by Shim et al.³ A new type adsorbent was prepared by Choi et al.⁴ with an

affinity ligand, for the PP films modified with amino acid groups such as α -phenyl alanine, α -cysteine, and α -tryptophane by radiation-induced grafting of glycidyl methacrylate (GMA) onto PP films and subsequent amination of poly-GMA graft films. Vinyl acetate was grafted onto LDPE film in an aqueous solution using *tert*-butyl alcohol as a compatibilizer and benzoyl peroxide (BPO) as an initiator.⁵ Graft copolymers of poly(methyl methacrylate) with spherical and high porosity PE/PP in situ alloys were synthesized by a solid-state graft copolymerization using free radical initiator. The effects of the various reaction parameters were studied.⁶ Graft copolymers of functional PP-containing hydroxyl groups were prepared by graft copolymerization of methyl methacrylate and styrene by atom transfer polymerization using a 2-bromopropionic ester macro initiator.⁷ Effect of solvent on γ -radiation-induced graft copolymerization of MMA onto PP has been studied by Naser and Man.⁸

From the literature survey it is therefore inferred that the modification of PP through grafting is being successfully pursued. However, modification of PP by grafting a polymer through intercrosslinking has not been reported. Therefore, in the present article we report on the grafting of poly(vinyl alcohol) (PVA) onto preirradiated PP powder through inter-

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crosslinking. PVA, a polyglycol is a nontoxic material and is used for the preparation of agriculture netting, packaging, textiles, cosmetics, bacteriostatic agents, and other externally applied medicines. It is the most readily biodegradable polymer of vinyl polymers.⁹ It is readily degraded in waste-water-activated sludge. Its water solubility, reactivity, and biodegradability make it a potentially useful material.

EXPERIMENTAL

Materials

Commercial PP was obtained from Thukral Trading, Delhi, India. Irradiation of the polymer was carried out from Co⁶⁰ source housed in Gamma Chamber-900 at a constant dose rate of 3.40 kGy/h. PVA (Merck) and BPO (Merck) were used as received.

Graft copolymerization

To the preirradiated, dried, and weighed PP (200 mg) suspended in a known volume of water (0–20 mL) was added a definite amount of PVA (0.100–0.250 g) dissolved in a known volume of water (0–20 mL) and a definite amount of the initiator, BPO (0.100–0.300 g). The reaction flask was placed in a water bath maintained at constant temperature (45–75°C), under constant stirring in nitrogen atmosphere for a definite interval of time (60–210 min). After the stipulated time period, the flask was removed from the water bath and the contents were filtered. The residue contains grafted PP, unreacted PVA, unreacted PP, and some amount of BPO. The residue was washed with benzene to remove unreacted BPO. The left over product was dried at 45°C till constant weight and this is referred to as the "Composite." Apparent percentage of grafting of the composite was calculated from initial increase in the weight of original PP as follows:

$$\% \text{Apparent grafting} = \frac{W_c - W_o}{W_o} \times 100$$

where, W_o and W_c are the weights of the original PP and composite, respectively.

The composite was then stirred with water for 2 h at 60°C to remove ungrafted PVA. The reaction mixture was filtered and the residue was dried at 45°C and weighed till constant weight was obtained. Percentage of grafting of PVA onto PP is calculated as follows:

$$\% \text{Grafting} = \frac{W_g - W_o}{W_o} \times 100$$

where W_o and W_g are weights of pristine PP and the graft copolymer, i.e., PP-g-PVA after the complete removal of the ungrafted PVA, respectively.

The graft copolymer was further stirred for 2 h at 60–70°C with *p*-xylene to remove the unreacted backbone polymer, i.e., PP. The reaction mixture was filtered, the residue was dried at 45°C, and weighed till constant weight was obtained. The product is the "True graft" and the percentage of true graft was calculated as follows:

$$\% \text{True grafting} = \frac{W_t - W'_o}{W'_o} \times 100$$

where W_t is the weight of the grafted PP after water and xylene washing and W'_o is the weight of PP obtained after hydrolysis.

True graft was hydrolyzed with 6N HCl for 4 h. This results in the hydrolysis of grafted PVA from the polymer backbone leaving the backbone polymer, PP. The solution was filtered and residue, i.e., PP was dried and weighed.

Graft copolymerization of PVA onto PP was carried out as a function of different reaction variables such as time of reaction, concentration of BPO, amount of water, and temperature. The optimum conditions were thus evaluated for achieving the maximum percentage of grafting.

The optimum conditions were used to study the effect of amount of PVA on % apparent grafting, % grafting, and % true grafting and the results are presented in Table I.

Characterization of PP grafted samples

Physical characterization of PP grafted samples has been done by FTIR spectroscopy, thermogravimetric analysis (TGA) and scanning electron micrographs (SEMs).

Swelling and solubility behavior

Swelling behavior of pristine PP and PP-g-PVA (both composite and true graft) was studied in different polar solvents. Samples each of pristine PP, PP-g-PVA (composite and true graft) were separately suspended in a total of 10 mL of the neat solvent

TABLE I
Effect of Variation of Amount of PVA on Grafting

Amount of PVA (g)	% Apparent grafting	% Grafting	% True grafting
0.100	20	25	25.00
0.150	40	25	33.30
0.200	80	75	33.30
0.250	65	60	14.29

PP, 0.200 g; [BPO], 5.51×10^{-2} mol/L; time, 120 min; temp., 70°C; water, 5(10) mL (total, 15 mL).

(water, EtOH, DMSO, and DMF), binary solvent mixture (water : EtOH), ternary solvent mixture (water : EtOH : DMSO), and quaternary solvent mixture (water : EtOH : DMSO : DMF) in different ratios at room temperature (25°C). The samples were filtered after 24 and 48 h. The adhered solvent was dried by gentle pressing between the folds of filter paper and weighed immediately. The percent swelling was determined from the increase in the weight of the original sample as follows:

$$\% \text{Swelling} = \frac{W_s - W_o}{W_o} \times 100$$

where W_s is the weight of swollen polymer and W_o is the weight of original polymer.

The swollen sample was dried in an oven at 50°C until constant weight is obtained. Percent solubility was calculated from the following equation:

$$\% \text{Solubility} = \frac{W_o - W_d}{W_o} \times 100$$

where W_o is the weight of original polymer and W_d is the weight of dried sample after swelling.

Water retention studies

Percent swelling of pristine PP and PP-g-PVA (both composite and true graft) in water was determined as a function of variation of time (4, 8, and 16 h), temperature (30, 40, and 50°C) and pH (4, 7, and 9.2). Samples of pristine PP, PP-g-PVA (composite and true graft) were immersed in water (30 mL) of known pH maintained at definite temperature and kept for predetermined time period. After the stipulated time period the contents were filtered. The residue was gently pressed between the folds of filter paper to remove the adhered water and weighed immediately. The percent swelling was calculated as above.

To determine the water retention behavior of different samples, the swollen sample was allowed to dry in the open at room temperature and the samples were weighed initially after 2 h followed by weighing after an interval of 1 h till the constant weight was obtained. Percent water retention of the samples was calculated w.r.t. percent wt. loss as follows:

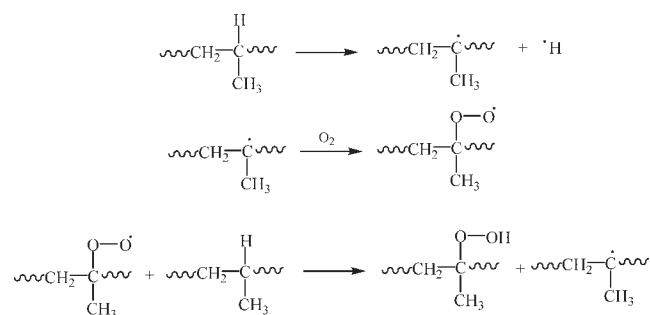
$$\% \text{Wt. loss} = \frac{W_{st} - W_o}{W_o} \times 100$$

where W_{st} is the weight of swollen polymer at respective time period and W_o is the weight of original polymer.

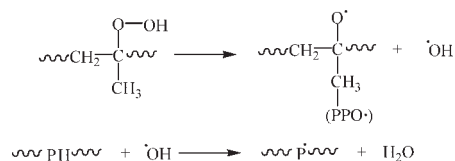
RESULTS AND DISCUSSION

Irradiation of PP leads to the formation of hydroperoxide groups onto polymer backbone where grafting of PVA occurred in the presence of BPO. Following tentative mechanism is proposed to explain the process of graft copolymerization of PVA onto PP.

Irradiation of PP

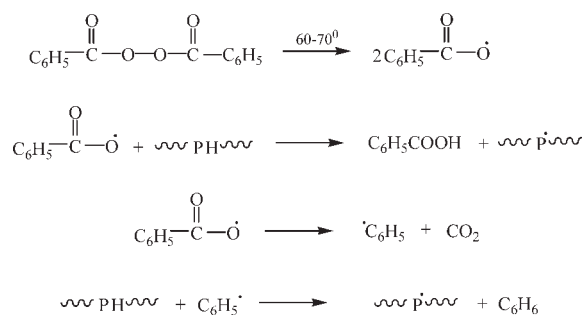


The hydroperoxide groups decompose upon heating to generate macroperoxy radical PPO· and hydroxyl radical.



where, PH is PVA.

The decomposition of BPO also generates active radicals which activate PVA through hydrogen abstraction.



Optimum conditions pertaining to maximum percentage of grafting (P_g) were evaluated and the results are discussed in the following sections.

Effect of time

Figure 1 represents the plots of percent grafting of PVA onto PP as a function of time. It is observed that P_g increases with increase in the reaction time giving maximum grafting (70%) within 120 min and decreases thereafter. The decrease in grafting may be

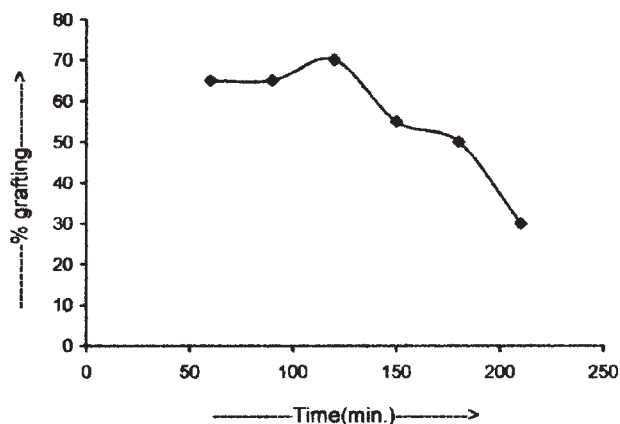
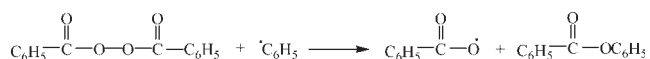


Figure 1 Effect of time on % grafting. PP, 0.200 g; PVA, 0.200 g; [BPO], 5.51×10^{-2} mol/L; temperature, 70°C ; water, 5(10) mL; optimum time, 120 min.

due to induced decomposition of the initiator leading to decrease in the concentration of the initiator and hence active radicals required to generate active sites on polymeric backbone.



Effect of [BPO]

Graft copolymerization of PVA onto PP was studied as a function of [BPO] and the results are presented in Figure 2. It is observed from the figure that the percent grafting of PVA onto PP increases with increase in [BPO] giving maximum (70%) at [BPO] = 5.51×10^{-2} mol/L. Further increase in the concentration of BPO, beyond optimum value decreases percentage of grafting. This may again be due to the reason that at higher concentrations BPO undergoes induced decomposition, leading to decrease in the radical concentration and hence lowers the graft copolymer formation.

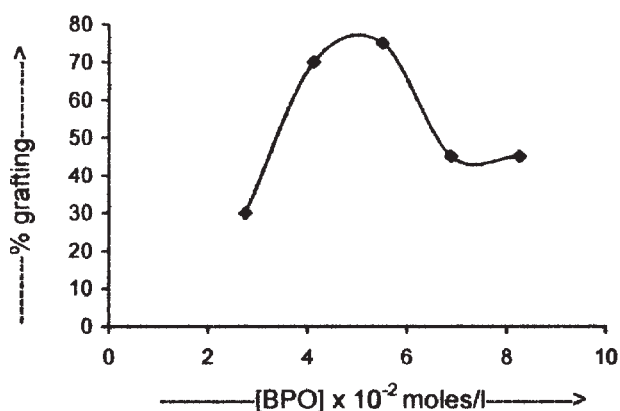


Figure 2 Effect of [BPO] on % grafting. PP, 0.200 g; PVA, 0.200 g; temperature, 70°C ; time, 120 min; water, 5(10) mL; optimum [BPO], 5.51×10^{-2} mol/L.

Effect of water

Graft copolymerization of PVA onto PP has been studied as a function of amount of water on Pg. The effect of the variation in the amount of water on Pg was studied both during irradiation of PP and also during grafting of irradiated PP with PVA and the results are presented in Figure 3.

It is observed from Figure 3 that maximum percentage grafting (75%) of PVA onto PP was obtained when PP was irradiated in 5 mL of water. Further increase in the amount of water continuously decreased the percentage of grafting. Keeping 5 mL as the optimum amount for irradiation, the effect of variation in the amount of water during grafting reaction was studied.

When the amount of water was varied during grafting, it is observed (Figure 3) that Pg increases with the increasing amount of water giving maximum (75%) when additional 10 mL of water was added. Further, increase in the amount of water decreases Pg.

Thus, maximum grafting (75%) was obtained in total optimum amount of 15 mL beyond which it decreases. The decrease in Pg with increasing the amount of water is due to the reason that PVA imbibes excess amount of water which may hinder the interaction between the polymer backbone and macroradicals.

Effect of temperature

The effect of temperature on Pg of PVA onto PP was studied and the results are presented in Figure 4. It is observed from the figure that Pg increases with increase in temperature giving maximum (75%) at 70°C . Further increase in the temperature decreases percentage of grafting. Increase in Pg with increasing temperature is due to increase in the decomposition of the initiator leading to the formation of more free

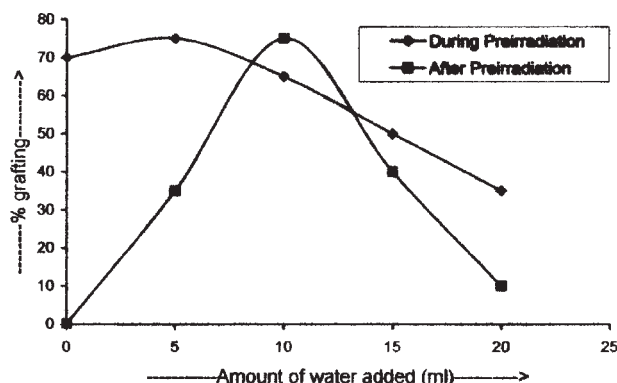


Figure 3 Effect of amount of water on % grafting. PP, 0.200 g; PVA, 0.200 g; time, 120 min; temperature, 70°C ; optimum amount of water during preirradiation (after preirradiation), 5(10) mL; [BPO], 5.51×10^{-2} mol/L.

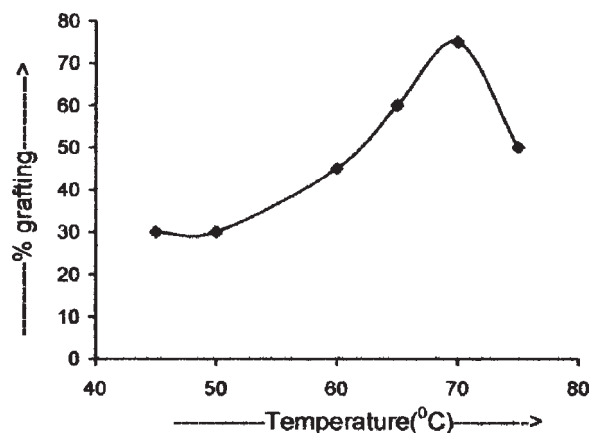


Figure 4 Effect of temperature on % grafting. PP, 0.200 g; PVA, 0.200 g; [BPO], 5.51×10^{-2} mol/L; time, 120 min; water, 5(10) mL; optimum temperature, 70°C.

radicals and generation of active sites on the polymeric backbone. Decrease in Pg beyond optimum temperature is attributed to premature termination of the growing polymeric chains and to the occurrence of chain transfer reactions.

Evidence of grafting

The evidence in favor of the formation of the graft, i.e., PP-g-PVA has been based on the IR spectroscopic, TGA, and SEMs.

FTIR analysis

FTIR spectra of pristine PP and PP-g-PVA have been taken on Thermo-5700 spectrophotometer. The FTIR spectrum of PP shows characteristic peaks at 2921–2958, 1377.3, 1459.1, and 998.3 cm^{-1} , respectively, for —CH (stretching vibrations), —CH (symmetric bonding) —CH (asymmetric bending), and —CH (out of plane bending). The FTIR spectra of PP-g-PVA apart from the above given peaks due to PP show a new peak for —COC— appearing at 1034.6 cm^{-1} , and also a broad spectrum for —OH (polymeric association of hydroxy groups) at 3400–3200 cm^{-1} was observed. The presence of additional peaks in the grafted samples supports the formation of graft copolymer of PP and PVA.

TGA

TGA of pristine PP, PVA, and PP-g-PVA was carried out in nitrogen (200 mL/min) atmosphere at a rate of 10°C/min on Perkin-Elmer (Pyris Diamond, Roorkee, India) and the respective thermograms are presented in Figure 5. The initial decomposition temperature (IDT), final decomposition temperature (FDT),

and decomposition temperature (DT) at every 10% weight loss for each sample is presented in Table II.

It is observed from Figure 5 that pristine PP, PVA show single stage decomposition and PP-g-PVA (composite) shows double stage decomposition curve. It is analyzed from IDT and FDT values that IDT of PP-g-PVA (composite) is much lower (105°C) than those of pristine PP (425°C) and PVA (255°C) whereas FDT of grafted PP and pristine PP lies close to each (460 and 470°C, respectively) and FDT of PVA (280°C) is much lower. The DT values at every 10% wt. loss of the PP-g-PVA (composite) are lower than pristine PP but higher than that of PVA after 40% decomposition. Temperature difference between every 10% wt. loss of pristine PP is very low indicating a fast rate of decomposition.

The grafted PP shows loss of moisture in the temperature range from 105 to 116°C with 44% wt. loss. The initial decomposition starts from 387°C with 43.62% residue left, which is fully decomposed to 0% up to 460°C. The temperature difference for PP-g-PVA (composite) between the first two 10% wt. loss is very low (2 and 3%, respectively). It starts increasing up to 124% for 40–50% wt. loss. After attaining maximum temperature difference it again decreases to 17% for 90–100% wt. loss.

On perusal of the thermal data thus it is observed that when PP is grafted with PVA its thermal stability get reduced by 320°C (= temperature difference of IDTs) in the starting whereas in the end both the samples, i.e., PP and grafted PP decomposed with the only temperature difference of FDTs, i.e., 10°C.

SEMs

SEMs of PP and PP-g-PVA at different magnifications (i.e., 500 and 2000×) have been taken on LEO vp 435 instrument and presented in Figures 6(a,b) and 7(a,b), respectively. The comparison of the SEMs

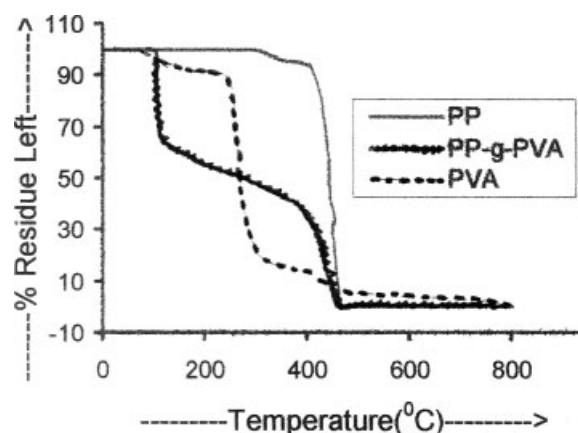


Figure 5 Primary thermogram of PP, PVA, and PP-g-PVA.

TABLE II
Thermogravimetric Analysis of Pristine PP, PVA, and PP-g-PVA Samples

Sample	IDT (°C) (at % residue left)	FDT (°C) (at % residue left)	DT (°C) at every 10% wt. loss									
			10	20	30	40	50	60	70	80	90	100
PP	425 (99.98)	470 (0)	414	428	436	440	444	447	451	454	459	470
PVA	255 (90.67)	280 (21.02)	237	256	260	264	268	274	284	304	431	^a
PP-g-PVA	105 (99.04)	460 (0)	107	109	112	153	277	380	414	430	443	460

^a % Residue left, 1.

of the grafted PP with that of pristine PP shows clearly the change in the topology of the PP surface. Grafting of PVA onto PP opens up its matrix and shows considerable deposition of PVA on the surface of backbone polymer.

Swelling and solubility behavior

Percent swelling and percent solubility of PP and PP-g-PVA was studied in pure, binary, ternary, and quaternary polar solvent systems and the results are presented in Figures 8–11. It is observed from Figure 8 that PP being a hydrophobic hydrocarbon shows neither swelling nor solubility in water. However, it shows high swelling percentage in EtOH (220 and

240%), and DMF (190 and 270%) in 24 and 48 h, respectively. Percent swelling, however, goes on decreasing with the increasing addition of water in the binary solvent and also in the quaternary solvent system along with the addition of EtOH and DMSO. In DMSO, percent swelling and percent solubility (10%) in 48 h is too low. However, when the solvent system is shifted to the mixture of water, EtOH, and DMSO, maximum swelling percent (220 and 270%) in 24 and 48 h is observed in 3 : 2 : 5 (H₂O: EtOH: DMSO) ratio. Further increase in the amount of water and EtOH decreases % swelling. In the quaternary solvent system, addition of water, EtOH, and DMSO to DMF decreases percent swelling than that observed in pure DMF. The higher swelling percent

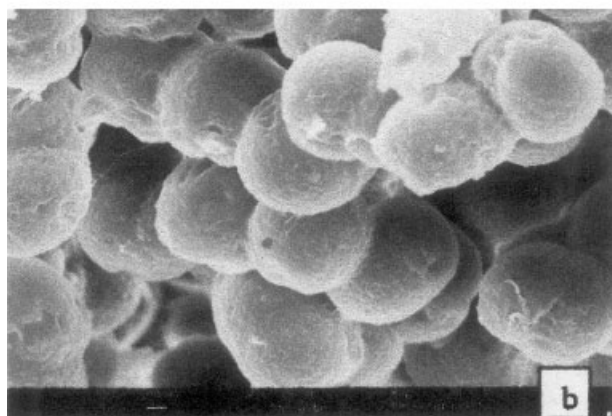
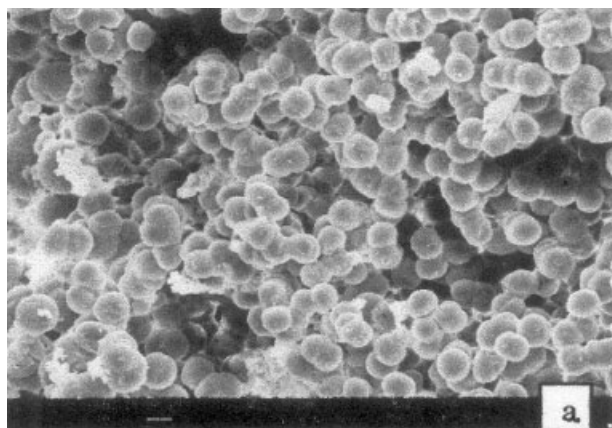


Figure 6 SEMs of pristine PP at (a) $\times 500$ and (b) $\times 2000$.

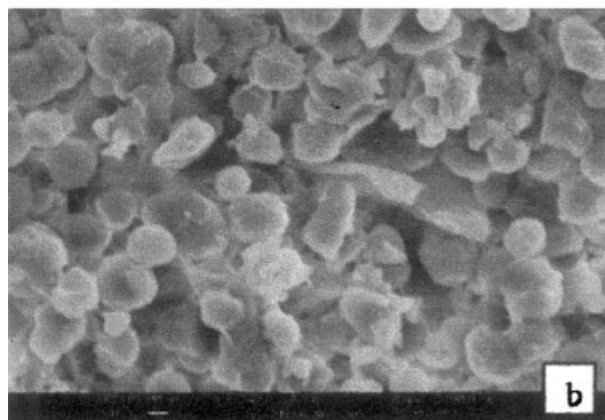
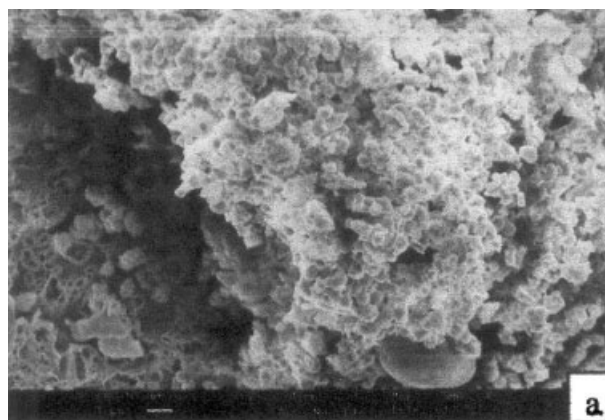


Figure 7 SEMs of PP-g-PVA (composite) at (a) $\times 500$ and (b) 2.00KX .

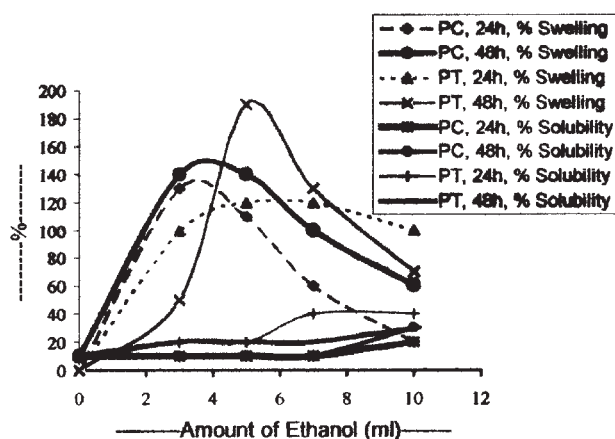


Figure 8 % Swelling and % solubility behavior of PP-g-PVA (composite) (PC) and PP-g-PVA (true graft) (PT) in binary solvent system (water : EtOH). [(0 : 10), (3 : 7), (5 : 5) and (7 : 3), and (10 : 0)].

of PP is observed in pure DMF. The higher swelling percent of PP attributed to the fact that the reprecipitated PP (from beads) offers a fluffy powder that holds the solvents within the empty spaces. PP, however, remains insoluble in all the solvent system in the present case. Similar studies when carried out on PP-g-PVA (both composite and the true graft), a different form of results were observed. Percent swelling decreased from that observed for PP while the grafted samples showed some solubility. In all the solvent system the true grafted samples show higher swelling and solubility percentage in comparison to the composites.

Maximum swelling percentage (190%) of PP-g-PVA (true graft) was observed in 5 : 5 water : EtOH while maximum solubility (50%) was observed for the composite in 2 : 2 : 3 : 3 (H₂O : EtOH : DMSO : DMF) solvent system. It is interesting to note that in pure DMSO, the grafted PP (both composite and true graft) shows much higher swelling as compared to PP.

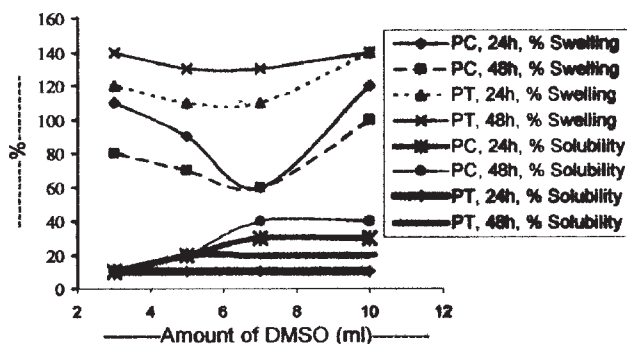


Figure 9 % Swelling and % solubility behavior of PP-g-PVA (composite) (PC) and PP-g-PVA (true graft) (PT) in ternary solvent system (water : EtOH : DMSO). [(0 : 0 : 10), (2 : 1 : 7), (3 : 2 : 5), and (4 : 3 : 3)].

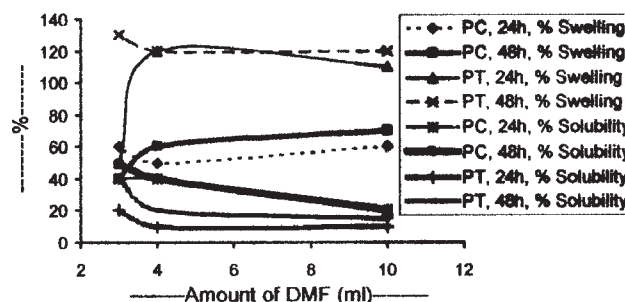


Figure 10 % Swelling and % solubility behavior of PP-g-PVA (composite) (PC) and PP-g-PVA (true graft) (PT) in quaternary solvent system (water : EtOH : DMSO : DMF). [(0 : 0 : 0 : 10), (1 : 1 : 4 : 4), and (2 : 2 : 3 : 3)].

On comparison of % swelling of PP-g-PVA (both for composite and true graft) in four pure solvents, the following order is observed:

$$\text{DMSO} > \text{DMF} > \text{EtOH} > \text{Water}$$

However, the order of these solvents giving maximum % swelling of PP observed is

$$\text{DMF}(270\%) > \text{EtOH}(240\%) > \text{DMSO}(10\%) > \text{Water}(0\%)$$

These results are explained by considering the dielectric constant (ϵ) and polarity index (PI) of these solvents. Water has the maximum ϵ and PI value (80 and 10.3, respectively) followed by DMSO (47.2 and 7.2), DMF (38.3 and 6.4) and least value of ϵ is observed for EtOH (24.3; PI not available). It was observed during swelling studies that the graft polymers suspended in these solvents were found to float on the surface of water whereas in the presence of DMSO, DMF, and EtOH or in their mixture with water, the polymers move into the bulk of the solvent system and completely get solvated. PP being a hydrocarbon lacks polarity and therefore shows maximum swelling in DMF with least PI. As the value of PI increases % swelling of pristine PP decreases with 0% swelling in water. When PP is

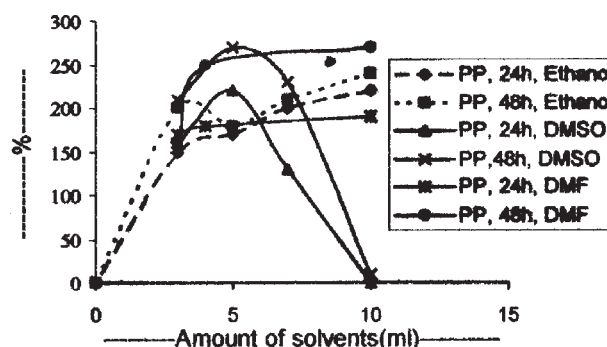


Figure 11 % Swelling and % solubility behavior of PP in binary, ternary, and quaternary solvent system.

TABLE III
% Water Swelling with Time, Temperature, and pH of PP and PP-g-PVA Samples and % Water Retention (% Moisture Loss) as a Function of Time of PP and PP-g-PVA

Samples	% Water swelling								
	Time (h) (temp., 30°C; pH, 7)			Temp. (°C) (time, 8 h; pH, 7)			pH (time, 8 h; temp., 50°C)		
	4	8	16	30	40	50	4.0	7.0	9.2
PP	0	0	2	0	2	10	3	10	7
PP-g-PVA (composite)	60	74	74	74	82	108	40	108	76
PP-g-PVA (true graft)	10	14	12	14	30	50	20	50	30

Time (h)	% Water retention (% moisture loss)								
2 ^a	0	0	0	0	0	0	0	0	0
2 ^b	30(30)	46 (28)	45 (29)	46 (28)	52 (28)	86 (22)	12 (28)	86 (22)	48 (28)
3 ^b	4(56)	20 (54)	20 (54)	20 (54)	27 (55)	60 (48)	0	60 (48)	20 (56)
4 ^b	0	0	0	0	2 (80)	30 (78)	0	30 (78)	0
5 ^b	0	0	0	0	0	2 (106)	0	2 (106)	0
2 ^c	0	0	0	0	0	24 (26)	0	24 (26)	7 (23)
3 ^c	0	0	0	0	0	6 (44)	0	6 (44)	0
4 ^c	0	0	0	0	0	0	0	0	0

^a Values for PP.

^b Values for PP-g-PVA (composite).

^c Values for PP-g-PVA (true graft).

graft copolymerized with PVA, a polyhydroxy compound, with pendant hydroxyl groups, the trend of swelling behavior shifts. Maximum swelling is observed in DMSO and least in water. The least swelling of the grafted samples in water may be due to the reason that there is no interaction of water with PP segment of graft and also the grafted samples remain on the surface with no proper salvations as in the case of other solvent.

Thus, grafting of PVA onto PP, introducing hydroxyl functionalities in the PP backbone makes the modified polymer soluble in pure solvent or different solvent systems along with swelling.

Water retention studies

The results of swelling percentage and water retention studies are presented in Table III. Swelling behavior of PP and PP grafted with PVA (both composite and true graft) was studied as a function of time, temperature, and pH. It is observed from Table III (refer to “% Water swelling”) that PP and the grafted samples (both composite and true graft) show maximum swelling (10, 108, and 50%, respectively) at 50°C in aqueous solution with normal pH (7.0) in 8 h. The % moisture loss as a function of time is presented in Table III [refer to “% Water retention (% moisture loss)"]. Swollen PP sample did not show any loss of moisture with time. In case of composite % moisture loss from each of the swollen sample (prepared as a function of time, temperature, and pH) shows a continuous rise after a period of every 1 h. After attaining a particular value, no

loss of water is observed. It is further observed that loss of water is consistent as observed for the different composite samples with 74 and 108% swelling.

Thus, from the data it is revealed that the PVA grafted PP (composite) swollen in water can retain water maximum up to 5 h beyond which no water loss is observed. This property can be useful for release of water over a period of time in arid region.

CONCLUSION

The results of present study thus reveal that PVA, a synthetic polymer, has been successfully grafted onto PP. The incorporation of PVA as graft has introduced better swelling and solubility behavior into PP. Water retention studies manifests the use of PVA grafted PP in arid regions.

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