# Study on effect of UV Radiation on D*egradability of PMMA Blends with Natural Polymers*

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***Abstract-***

PMMA(Poly-methyl meth acrylate) a thermoplastic which is stable and hard to decompose . In this study blends of PMMA were prepared with natural polymers like starch , cellulose and poly lactic acid in different proportions. Such blends were exposed to UV radiation for 15 to 30 days and then soil burial test applied for testing of biodegradability . It was observed that when percentage of natural polymer was more than 25% in the blend with vinyl polymer then transparency and strength of blend decreases and degradability approach increases Composite with 50% natural polymer was optimum with strength as well as biodegradation was achieved. It was also confirmed by FT-IR analysis. When blend was exposed to UV radiation for longer time then degradability of vinyl polymer was increased.

Key Words- PMMA, starch, PLA, biodegradability & blending

**Introduction**- Poly-methyl meth acrylate (PMMA) is well known very useful vinyl polymer which is also known as plexi glass or artificial glass due its high refractive index. It is thermally stable and also very hard to degrade or disposable is a problem . Vinyl polymer has scope for modification by crosslinking and blending. It can be modified by crosslinking as well as with grafting techniques in alkaline conditions where hydrochloric molecules are eliminated due to which double bonds are created and then scope for addition of other molecule is generated . Such modified vinyl polymers when modified by grafting and blended with appropriate proportions then new blended polymers are obtained with altered properties(1)..

In this study blends of Polymethyl meth acrylate(PMMA) with natural polymers like starch, cellulose and and poly-lactic acid(PLA) were prepared. Such blended polymers have good stability also. Such blend when exposed to long UV radiations then they show degradation sign during bio decomposition process. Such degradable blended polymers may be used in different applications as a substitute for non-biodegradable thermoplastics (2).

**Blending formation and UV exposure-** Methyl methacrylate monomer (MMA) powder (1-2gm ) was dissolved in 10 ml of organic solvent with some quantity of ml of benzoyl peroxide solution ( 0.5% w/v of toluene ) it was vigorously stirred. The solution was heated with stirring around 60- 70°C for about ½ hr and then varying quantity of blended natural polymer like starch ( 25% to 100% w/w of polymer) was added and some temperature was raised by 10 °C in next 15 mins and then further by 10 °C in next 1/2hr. when some insoluble concentrated mass was formed then it was filtered and washed with methanol and water. In 1975 Rabek, J and coworkers studied the degradation of polymer with photo-oxidation(2). Another study of biodegradation using polymer blends was done by Seema Kaval et al in 2019, They observed some useful blends with some biodegradability (3). Similarly another blended polymer with PMMA and PLA were prepared in same conditions. Blended modified polymer was formed in gel form which was separated and casted in petri-dish to get a thin film of blended polymer and it was dried at 35-40°C. After formation of transparent film it was exposed to UV radiation for 15 to 30 days .After exposure to UV radiation film was tested for biodegradability by soil burial test..

**Test of Biodegradability**: Soil burial test, which has been applied by many researchers for testing biodegradability(3) . In this test ,soil with sewage waste water was taken in a small box of about 10 cubic ft . PH was maintained in neutral range with small addition of vinegar or dilute ammonia. polymer sample after exposure to UV radiation in thin film form was weighed( 1-2 g ) then soaked in water for about 24 hrs and then buried in soil in middle of the box with maintaining moisture .In the box, waste water containing microorganism was added with some nutrients. Holes are maintained in box for passing air. after 3 months polymer samples were taken out and weight was taken for calculation of percentage loss in weight .Same tests were repeated for different blended polymers.

**Result Discussion**- PMMA as well as its blended polymers were tested for biodegradability by using soil burial test .After giving exposure of UV radiation ,significant sign of biodegradability was observed.

Results are shown in table-1. All samples were also characterized by using FT-IR and XRD. FT-IR spectra confirms the changes in bonding and In this study blended polymers have been prepared with some natural polymers, such stability along with blended polymers have shown thermal stability along with some significant sign of biodegradability.

In this study from benzoyl peroxide peroxide radicals are generated which attacks further on polymer to generate highly reactive phenyl radicals. Such free radicals attack further to generate free radicals and remove hydrogen.. Simultaneously modified vinyl polymer is being blended with some natural polymers like starch or poly-lactic acid(4). In this technique blending also may involve some stronger physical forces of attraction i.e. Vander Waal's forces of attraction. Modification of PVC was also done by Singh A et al in 2010 using basic amine solution (5 ).

Change in bond length and new bond formation is best confirmed by FT-IR and changes in crystalline nature depicted by XRD (6). FT-IR spectra are given in combined fig.1 (a to d) for polymer PVC as such, modified blend polymer with PLA, blend with starch and blends of PMMA respectively. fig-1 shows different peaks which clearly depictst modification in polymer and blends. Absorbance peak around 700cm-1 is due to C-Cl bond. Bands around 900-1350 cm-1 might be due to-C-H stretching vibrations. Other IR spectra shown in fig1.b to d confirms the modification or distortion in the bonding in the polymer(7-8). XRD spectra of polymer and its blend with PLA, starch and PMMA with blends are shown in fig 2.( a, b,c,& d respectively).

Biodegradation study was done by applying soil burial test in a soil box for all vinyl polymers and their blends and all were kept for optimum conditions of microorganism growth. Thin films of polymer blend after taking their weights were exposed to UV radiation for 15 to 30 days. After exposure all types of polymer blends were buried in soil fo 3 months .After 3 months loss in weight was calculated which are given in table.1. From the table-1 it can be concluded that biodegradation of PMMA in itself is very difficult in 3 months time but when PMMA polymer was exposed to UV radiation for about one month then degradation sign was observed and some weight loss of about 1% was also observed. When modified PMMA blends formed with starch and cellulose , then biodegradation was enhanced with 10-12 % weight loss in 3 months. Starch blends have shown almost same rate of degradation as compared to cellulose while PMMA—PLA blends have shown 16-18% weight loss in same 3 months duration. Higher weight loss may be due to extra mass deposition on the surface polymer. After exposure to UV radiation , rate of degradation of polymer blends increases. . Biodegradation of a material is

degradation carried out by the action of naturally occurring microorganisms via enzymatic action into metabolic products. In this process some simple molecules like carbon dioxide, water vapors, or methane and biomass may also be formed.(9).

Emad Yousif et al studied the Effect of UV radiation on PMMA and metal complexes in 2015.Biodegrdation was also attempted by Ludimila Vanharava et al in 2017 by blends of Poly( vinyl pyrolidine) with natural polymers. They studied the biodegradation of blend of PVP based materials in different environments. They observed slow degradation about 2 to 4 % in different conditions( 10 ). Andrady, A.L et al studied some similar study with exposure of UV radiation on different materials(11).

Overall in this study it can be concluded that vinyl polymer like PMMA can be biodegraded with the higher rate but with exposure of UV radiation to the blends. UV radiation makes the C=0, C-O or C-C bonding weaker which consequently may be approached by the bacteria in the suitable environment with lesser energy.

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**Fig-1( IR Spectra of Polymer-PMMA & Blends)**

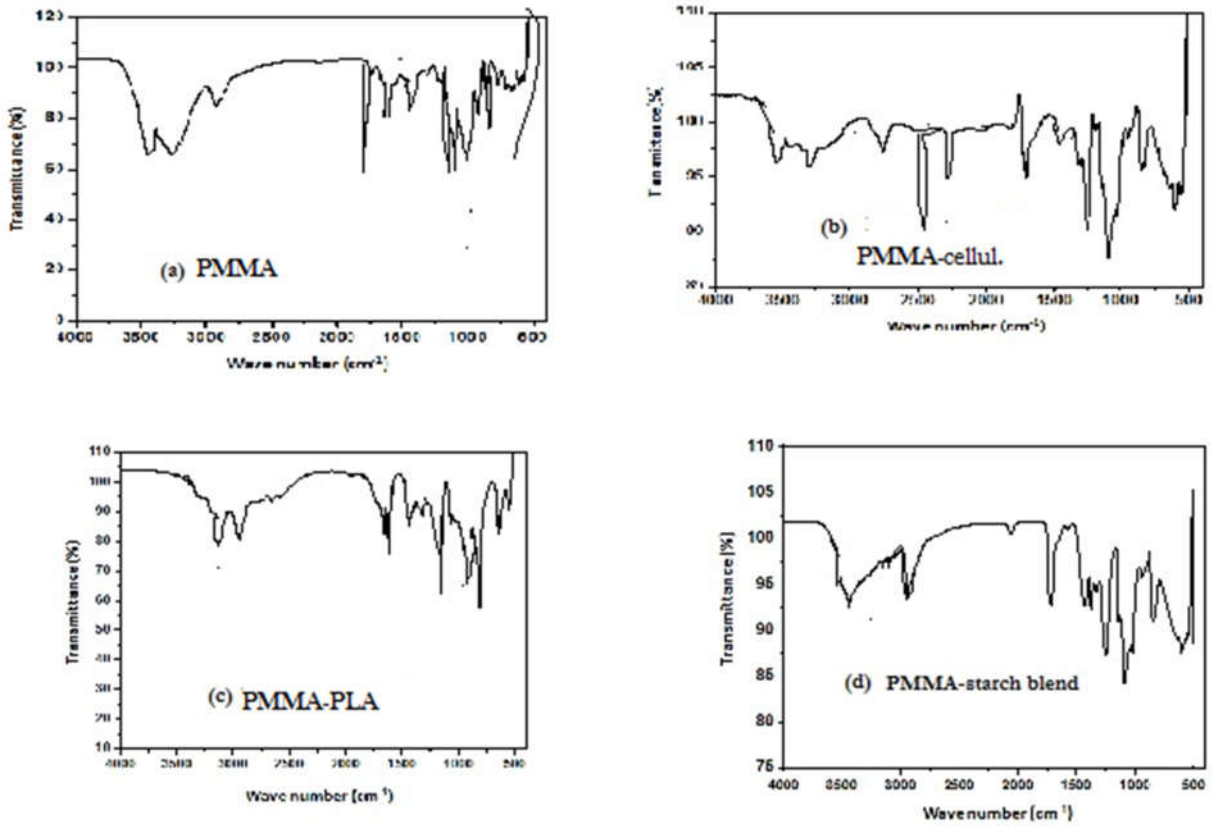


Fig-2 ( XRD of polymer & Blends)

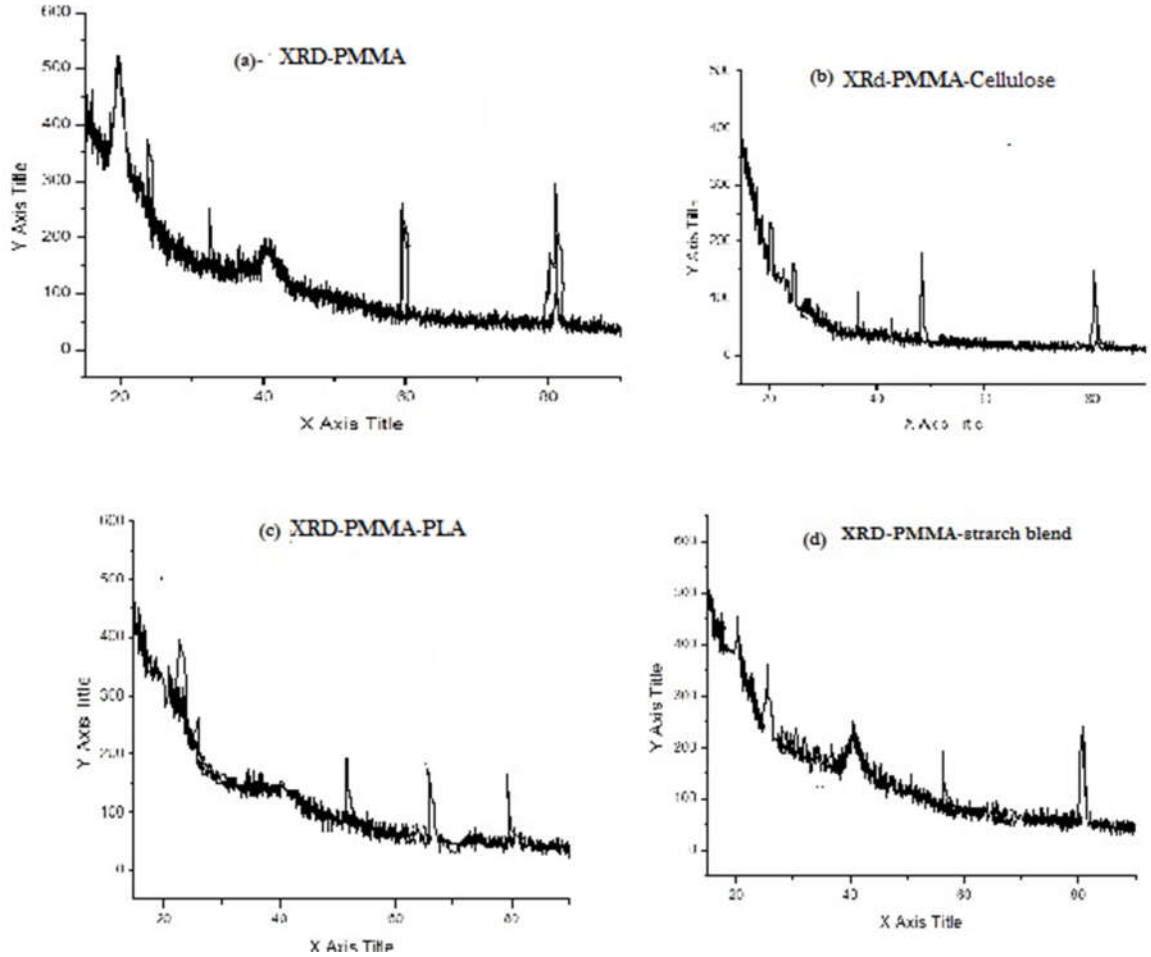


**Table-1 ( weight Loss study in Biodegrdation test & UV exposure time )**

| S. No. | POLYMER (P) | Blended with (B) | BLEND (B) % w/w of (P) | UV Exposure Of blend(days) | Loss in wt ( %) After 3 Months |
|---|---|---|---|---|---|
| **1.** | PMMA | - | 0 | 0 | 00% |
| **2.** | PMMA | - | 0 | 15 | 0.7% |
| **3.** | PMMA | Starch | 25 | 15 | 2.0% |
| **4.** | PMMA | Starch | 25 | 30 | 3 % |

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|---|---|---|---|---|---|
| **5.** | PMMA | Starch | 50 | 30 | 5.4 % |
| **6.** | PMMA | Starch | 100 | 30 | 12.2% |
| **7.** | PMMA | PLA | 50 | 30 | 7.5 % |
| **8.** | PMMA | PLA | 100 | 30 | 16 % |
| **9.** | PMMA | Cellulose | 25 | 30 | 3% |
| **10.** | PMMA | Cellulose | 50 | 30 | 5% |
| **11.** | PMMA | Cellulose | 100 | 30 | 11 % |