

Adhesion Improvement between Polyethylene and Aluminium Using Eco-Friendly Plasma Treatment

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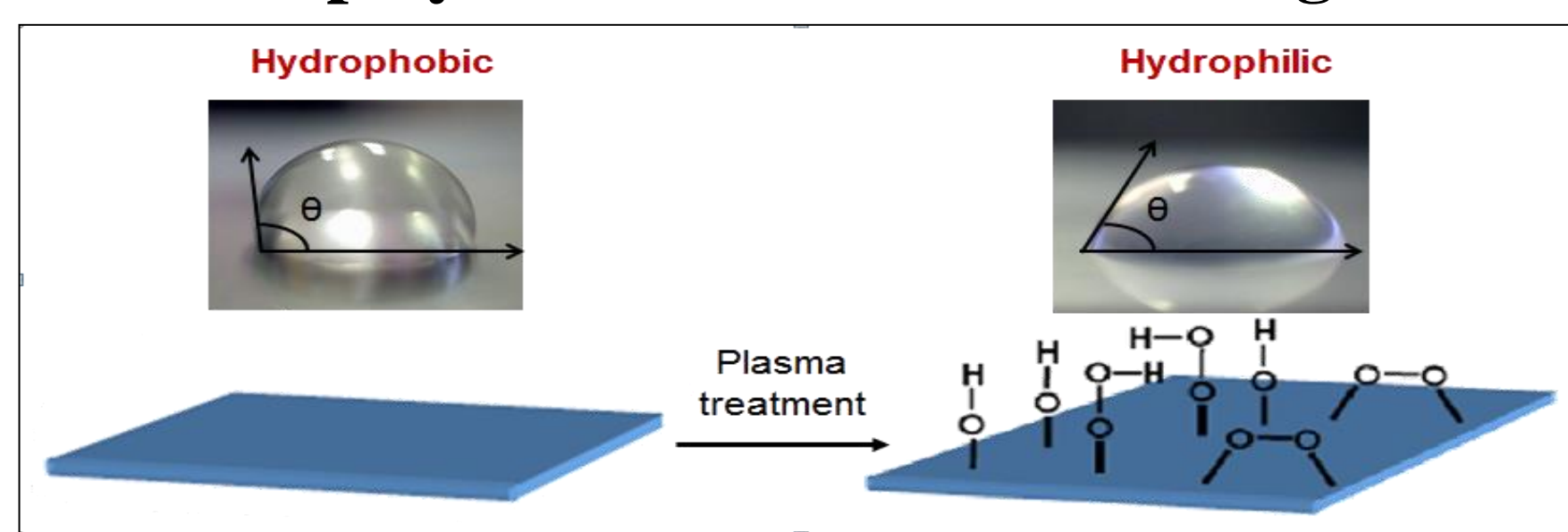
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INTRODUCTION

Laminates composed by a combination of low density polyethylene (LDPE) and aluminum (Al) foils are widely used in several industrial applications, especially in food packaging (Tetra Pak containers, e.g.). However the adhesion between PE-Al is relatively low due to hydrophobic surface of PE, so there is a strong need for surface modification of PE.

Corona discharge is a preferred surface modification technique for polymers since it's fast (few seconds of operation), economic (low cost), easily adapted to in-line operations, and environmentally friendly (no need to use aggressive chemicals)[1]. It operates by ionization the supply gas (ozone) in order to produce stream of charged particles such as electrons, ions, and oxygen radicals into the exposed (non-polar) surface, thus leads to create polar functional groups, i.e. hydroxyl, carbonyl, and carboxyl groups that are incorporated to the surface. As a result; the surface free energy and the wettability increase, the surface will be hydrophilic, and then adhesion characteristics between polymer-metal will enhance significantly [2].



RESULTS

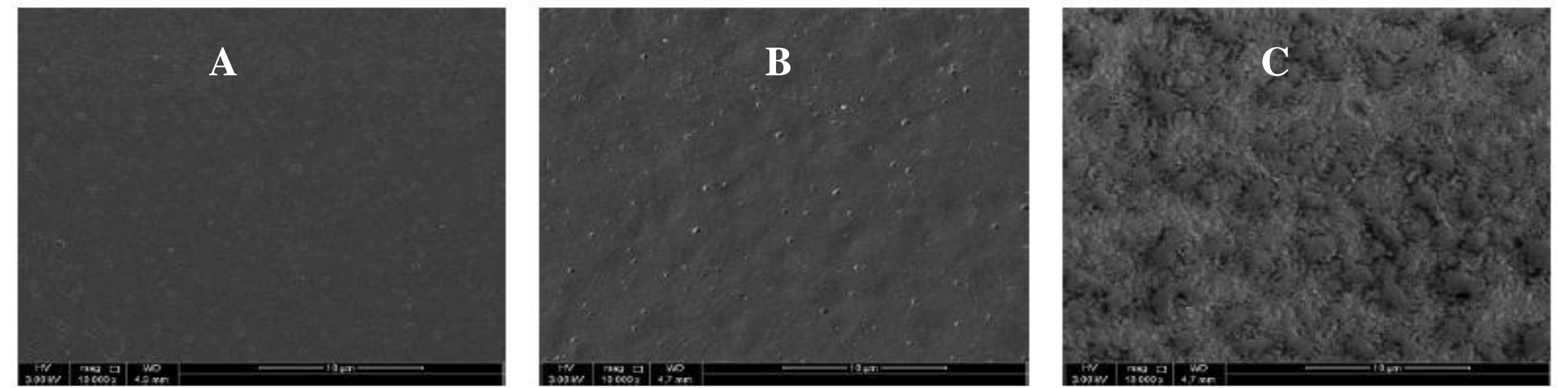


Figure 1: SEM images of LDPE
A: untreated, B: after 1s plasma treatment, C: after 7s plasma treatment

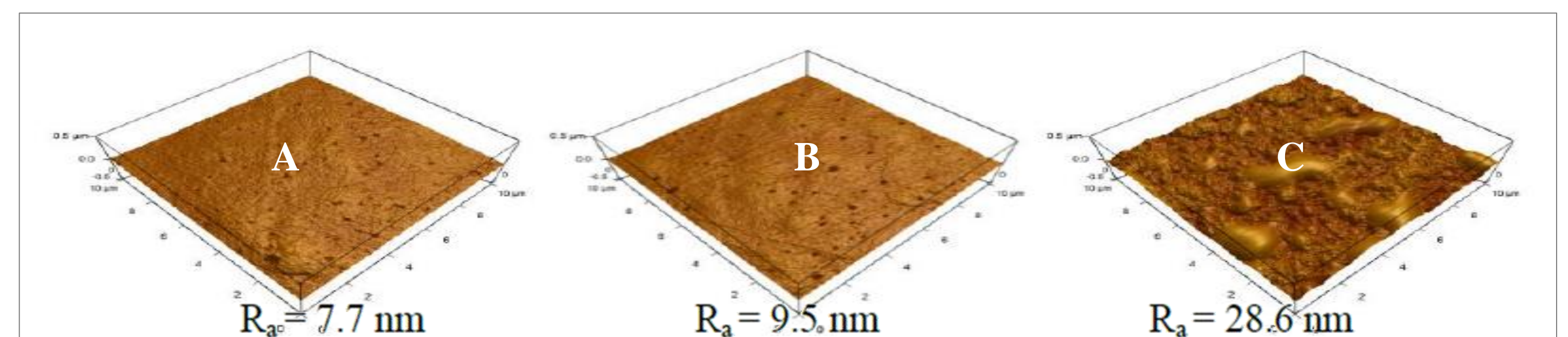


Figure 2: AFM images with roughness parameter (Ra) of LDPE
A: untreated, B: after 1s plasma treatment, C: after 7s plasma treatment

MATERIALS AND METHODS

Materials Used

Name of chemical	Source	Its use(s)
Low-density polyethylene (LDPE) granules	QAPCO, Qatar	Basic material in preparation of adhesive joints
Al foils	B & M Europe, Ltd., Slovakia	
Ultra-pure water	water purification system Direct Q3, France	Investigation of wettability of LDPE and Al foils
Ethylene glycol (EG)	Fluka™, Belgium	

Methodology

Mounting hot press machine 	Corona Plasma Discharge
Contact angle measuring system 	Peel testing system

Characterization techniques

 Scanning electron microscopy (SEM)	 Atomic Force Microscopy (AFM)	 Fourier-transform infrared spectroscopy (FTIR)
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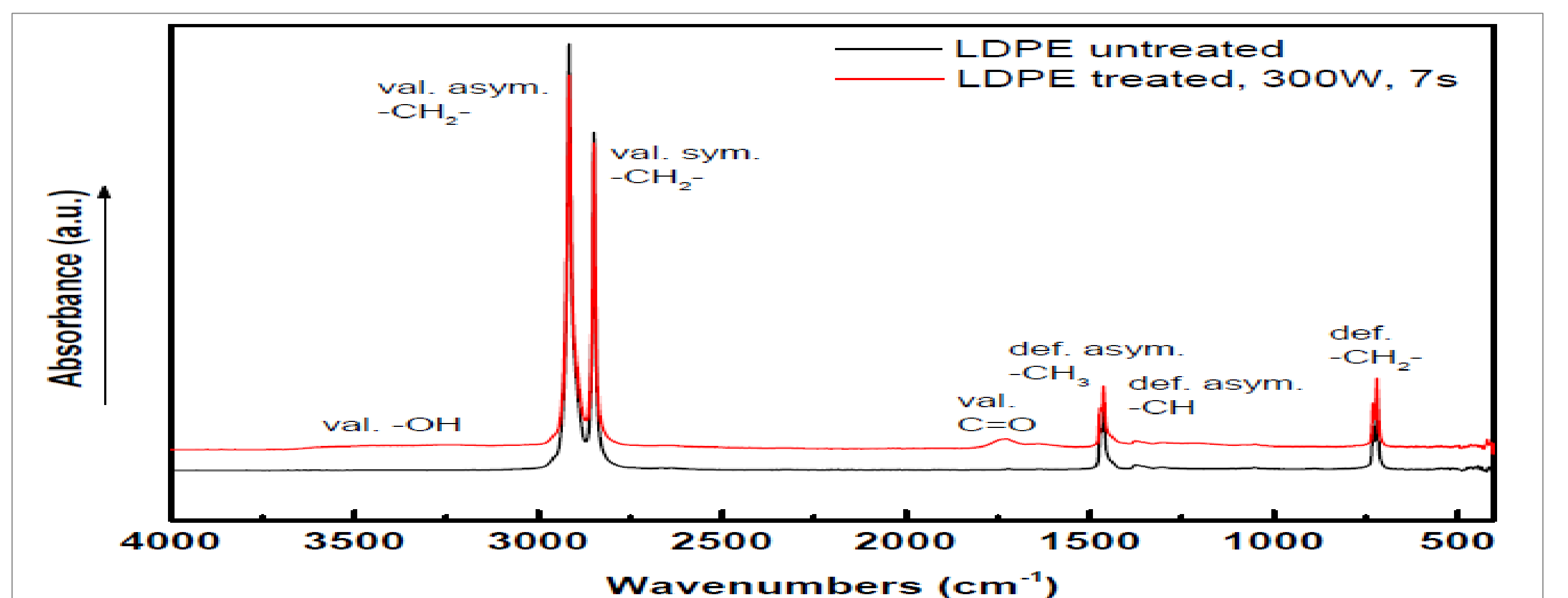


Figure 3: FTIR spectra of untreated and plasma treated LDPE

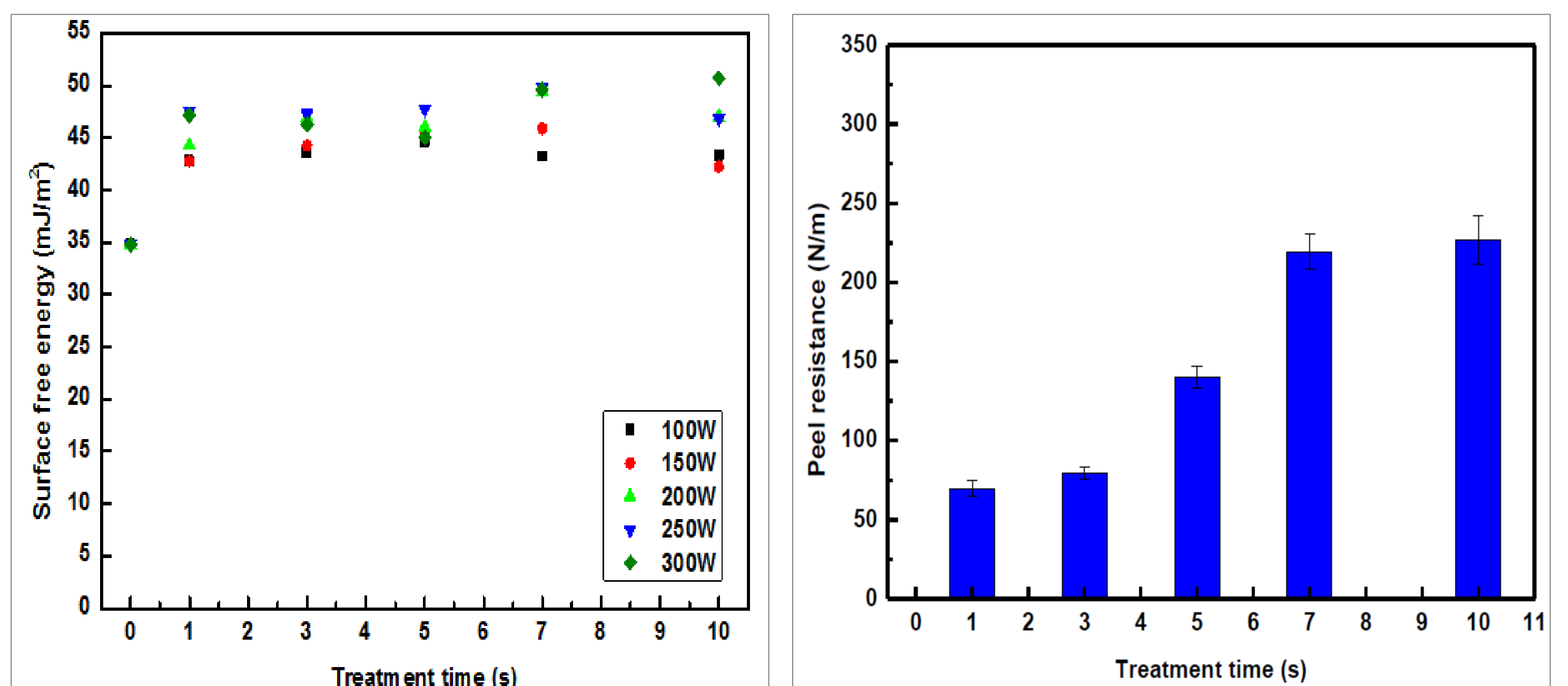


Figure 4: Surface free energy vs. treatment time of LDPE at different nominal power

Figure 5: Peel resistance (adhesive strength) of LDPE-Al adhesion joint at different treatment time

CONCLUSION

It was found that corona discharge had a positive and significant effect on the adhesive properties of LDPE. This technique succeeded to convert LDPE surface into hydrophilic charged surface, due to an increase in the wettability property which was determined by contact angles measurements. Furthermore, adhesive strength between LDPE/Al multilayers which were measured using peel tester indicated as the treatment time increases, the adhesion bond increases due to polarity and higher surface energy of modified LDPE surface.

REFERENCES

- [1]:Omnexus, E. M. P. (2013). White Paper Adhesive Bonding of Polyolefin White Paper. (June), 1–6
- [2]: Sanchis, M., Blanes, M., Blanes, V., & Sanoguera, D. (2006). Surface modification of low density polyethylene (LDPE) film by low pressure O2 plasma treatment. *European Polymer Journal*, 1558-1568.

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