Properties of polymeric films, modified in glowing charge plasma

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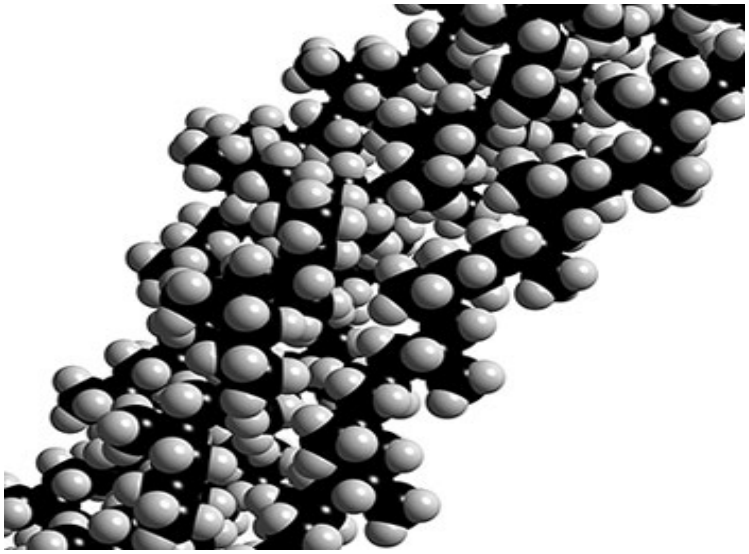
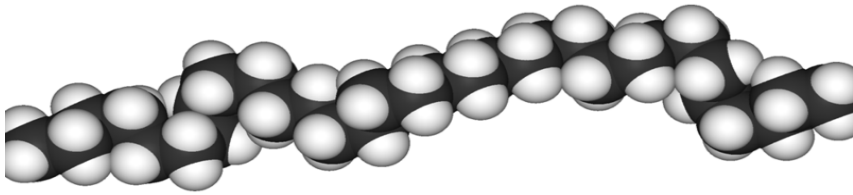
Frequently polymeric films are used as a packaging material for foods as well as for other products.

Subjects of inquiry description

- Polypropylene (PP)



- Polyethylene of low density (PELD)

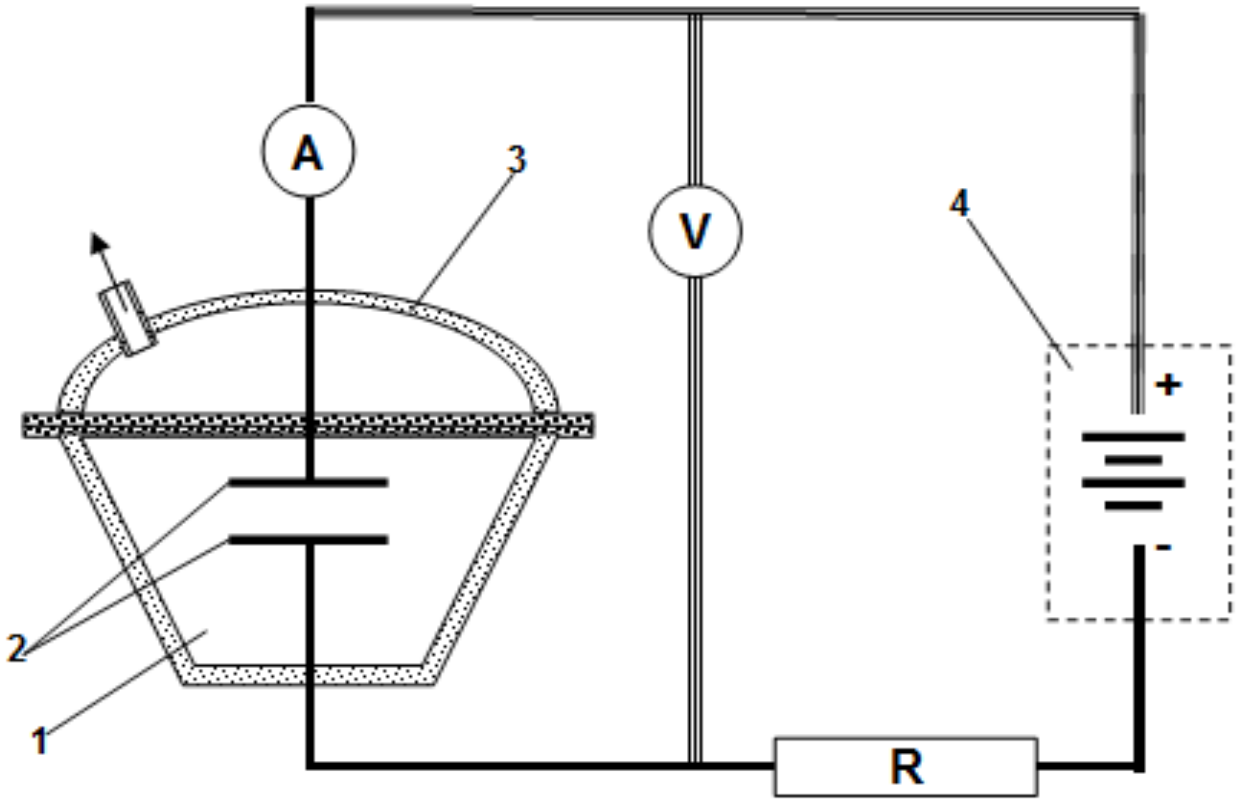


Properties of polypropylene and high pressure polyethylene films

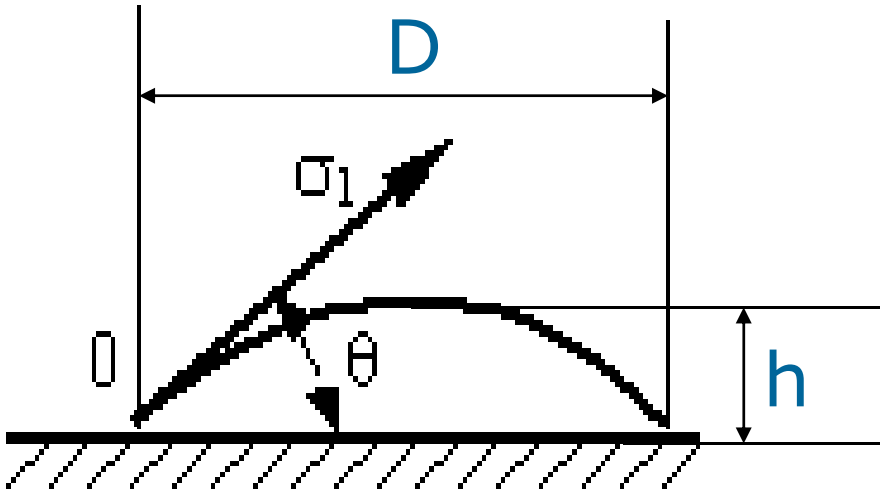
Film type	PP	PELD
Thickness, mm	0,1	0,1
Density, g/sm^3	0,90-0,91	0,918-0,935
Ultimate tensile strength, %	200-800	150-600
Tensile strength, MPa	25-40	12-16
Melting point, C	160-170	105-108
Bending modulus of elasticity, MPa	670-1900	150-250
Tensile yield stress , MPa	25-35	9-10

Properties of the solvents

Substance	Hexane	Isopropanolamine
Density, ρ 10^{-3} kg/m^2	0,6595	0,7851
Boiling-point, C	68,7	94,2
Surface tension, σ 10^3 N/m	18,42	21,7
Solubility parameter	7,6	11,9



Scheme of the setup for modification polymeric materials with glowing charge, 1 – chamber, 2 – electrodes, 3 - chamber cover, 4 - constant-current source.



$$W = \sigma_1(1 + \cos\theta)$$

$tg\Theta = (2\ r \cdot h) / (r^2 - h^2)$ r – radius

σ_1 - surface tension of liquid,
D – diameter of the drop,
h – height of the drop,
Θ - limiting wetting angle.

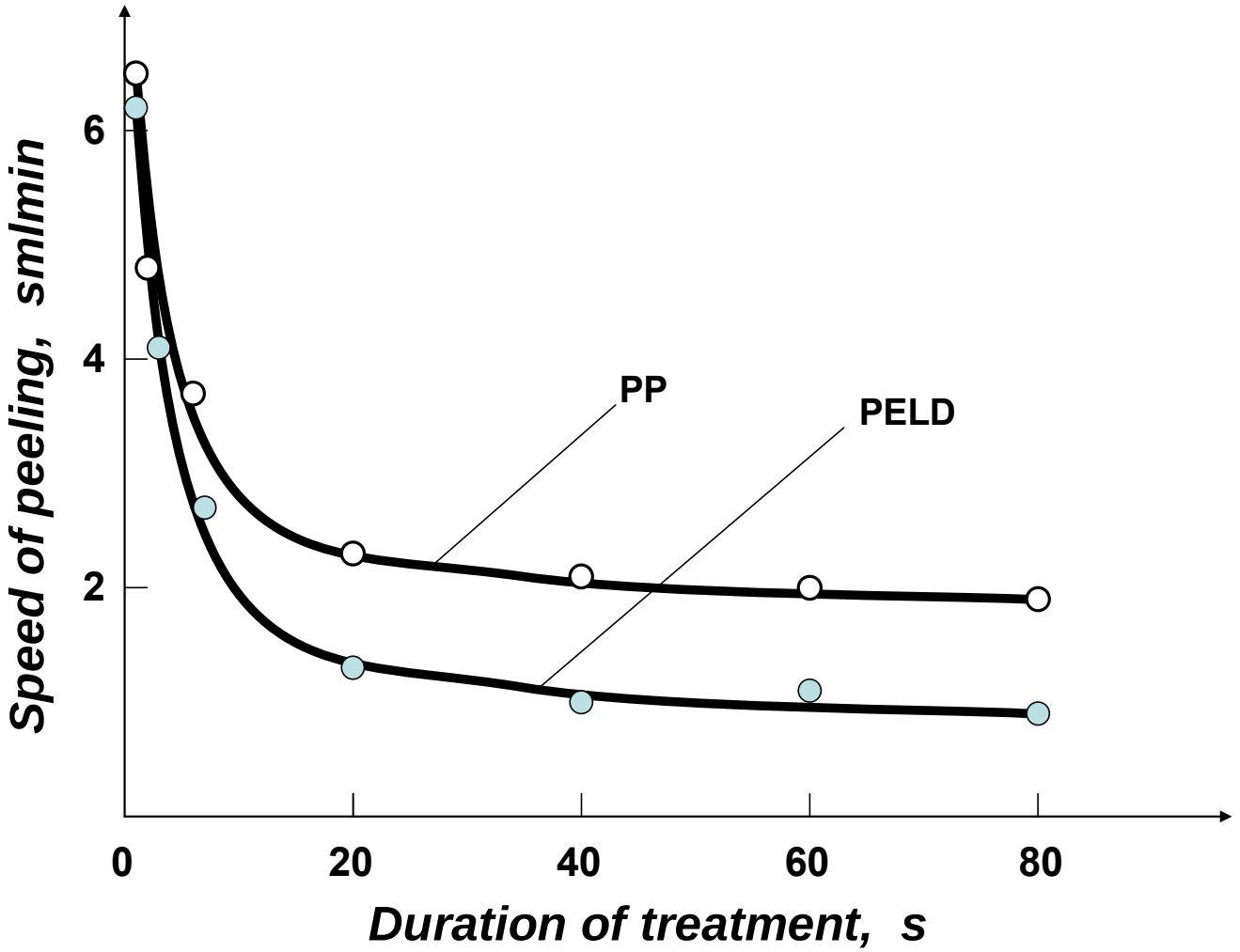
Experimental results

	Limiting wetting angle, degree	
Type of the pattern	H_2O	Ethylene glycol
Non modified	67 2	64 2
Modified	56 2	23 2

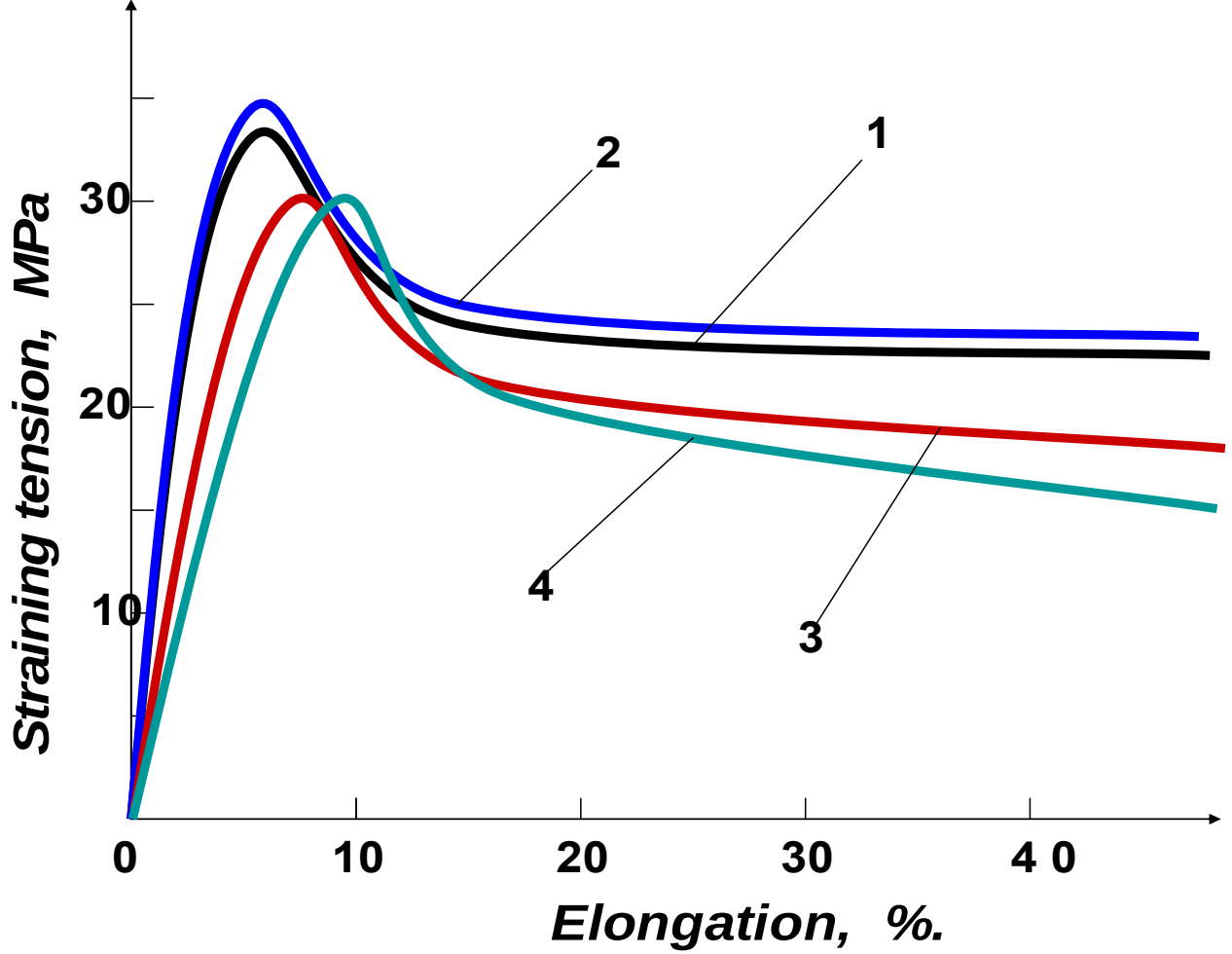
Surface energy of polymeric films were calculated using the equation:

$$(\cos\Theta + 1)\gamma_L = 2(\gamma_S^D \gamma_L^D)^{1/2} + 2(\gamma_S^P \gamma_L^P)^{1/2}$$

	Surface energy, mN/m	
Type of the pattern	PP	PE
Non modified	36,0	34,8
Modified	46,8	48,2

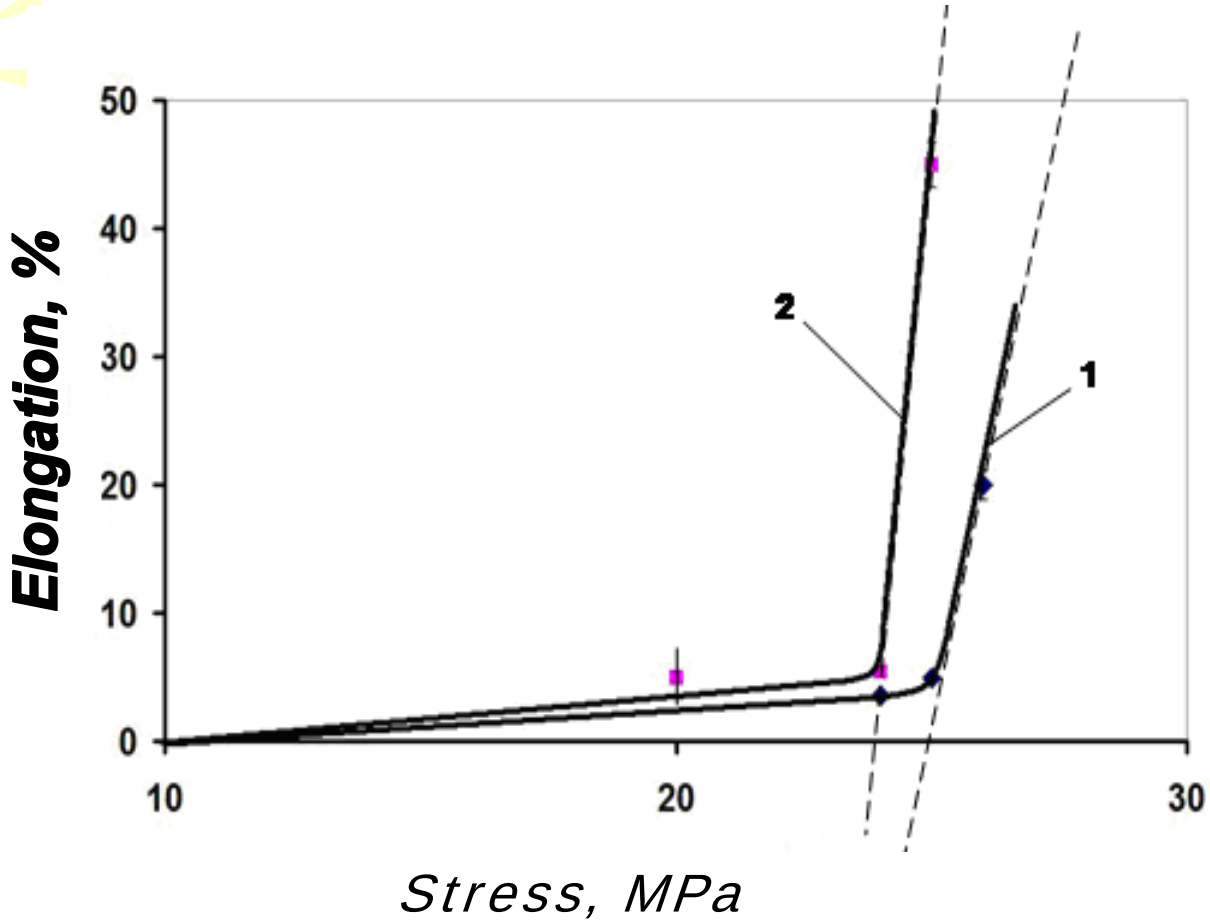


The dependence of adhesive ability of PELD and PP films on the duration of modification in glowing charge.

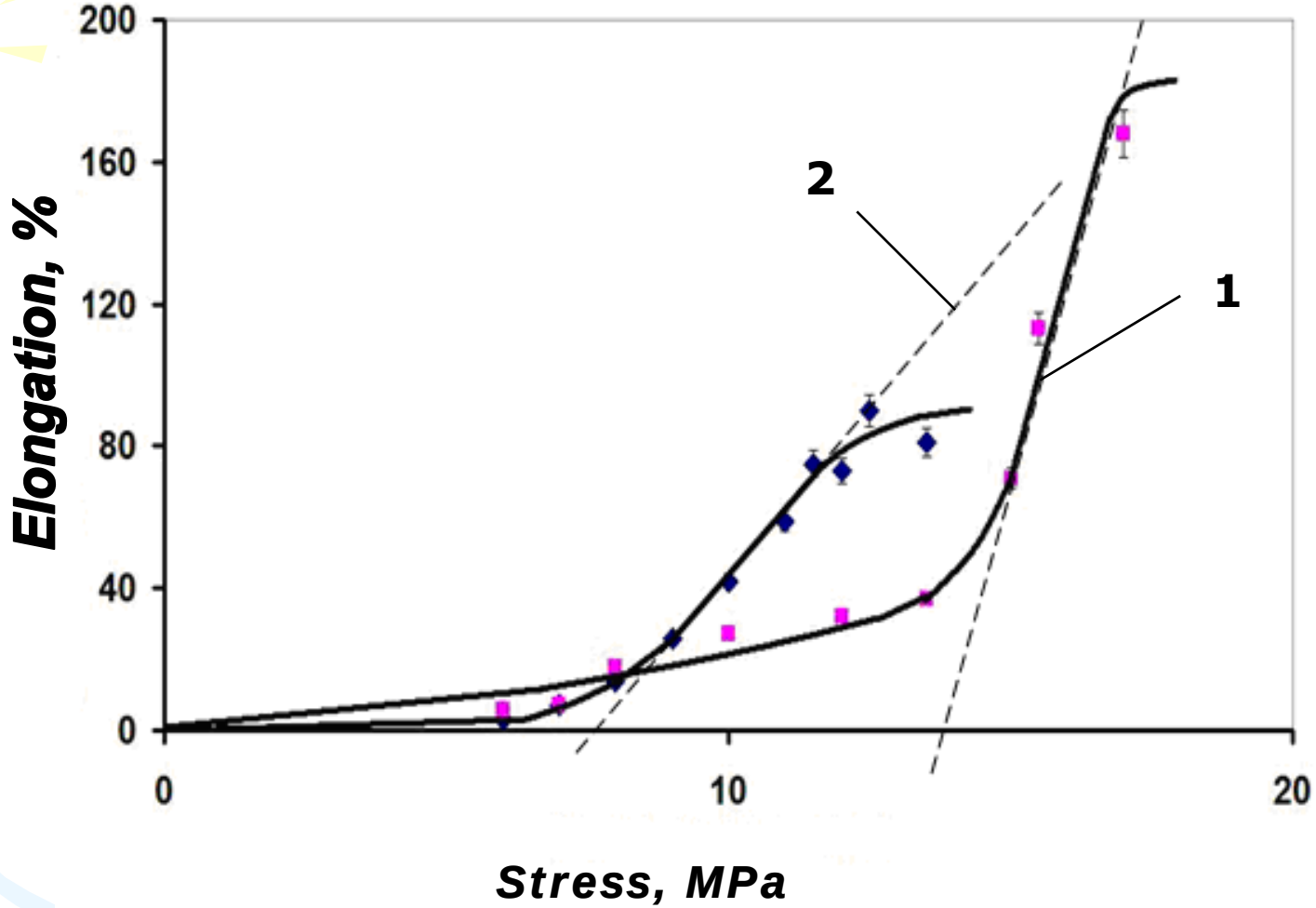


Deformative curvs of polypropylene film patterns:

1 – pattern wasn't treated with glowing charge, tested in the air
2 – pattern treated with glowing charge and tested in the air,
3 – pattern treated with glowing charge and tested in isopropanolamine,
4 – pattern treated with glowing charge and tested in hexane.



Creeping of PP film in the air:
1 – modified pattern
2 – original pattern



Creeping of PP film in the hexane:
1 – modified pattern
2 – original pattern

Summary

- Modification of polymeric films (PELD, PP) with glowing charge may lead to increasing of printing quality by essential growing of adhesive ability of modified films surface.

- Modification polymeric films surface with glowing charge practically doesn't decrease their physical-mechanical properties, but at the same time creeping of polymeric material in organic solvents distinctly decreases with growing of critical stress σ_{crit} practically twice.

Thank you for your attention