Introduction of PEL series
- Ion conductive additives for polymers

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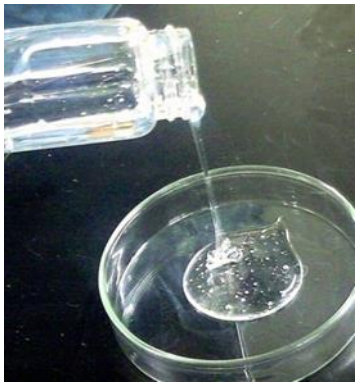
1. A special class of complex between Li^+ and poly(alkylene glycol)

2. Ion conductive w/ less humidity dependence

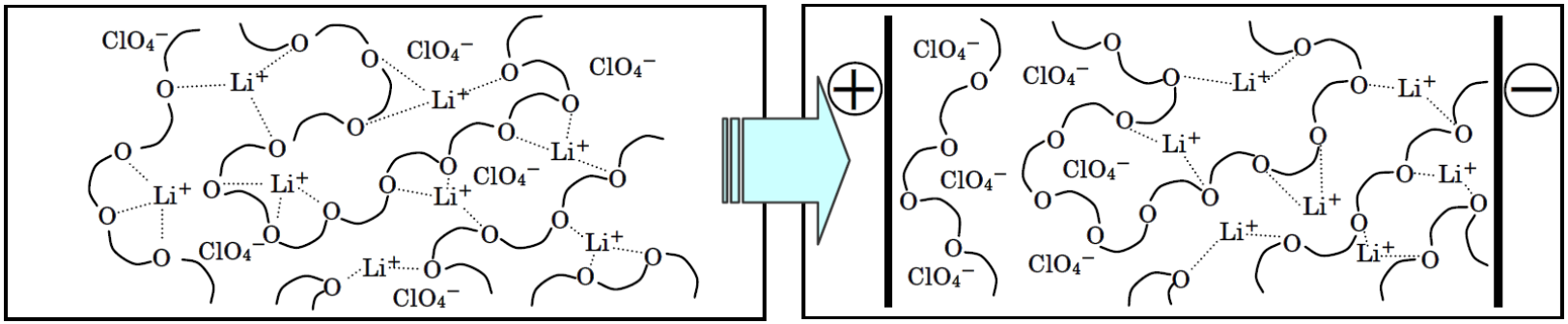
3. Transparent viscous liquid that can be added to polymer

   --- several types are available for optimal miscibility w/ polymers

4. Applicable to anti-static packaging for electronics parts, rubber parts etc.



1. Li^+ from Li salts, *e.g.* $LiClO_4$, solvates with (coordinated by) oxygen atoms in poly(alkylene glycol) then dissociate w/ ClO_4^-.
2. ClO_4^- is now easily mobile w/ assist of lattice vibration of the polymer chain while Li^+ is fixed to the polymer.
3. When electric field is applied, ClO_4^- shows high mobility.
   --- No assist of humidity is necessary.
   --- shows high conductivity under low humidity environment
4. Form conductive pathways in non-conductive polymer such as PVC, poly(urethane), *etc.* when composite of PEL w/ them are made



3. Conductivity dependence on humiditiy

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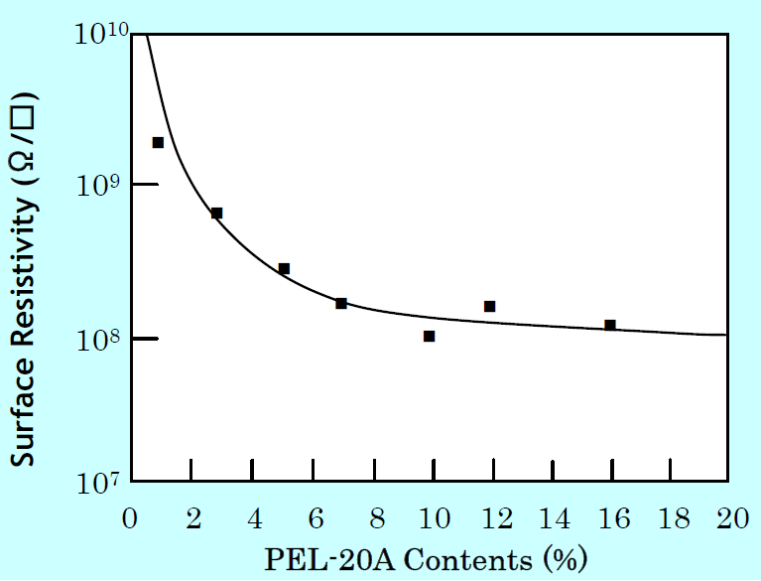

Fig. 1 Surface resistivity dependence on PEL 20A contents in poly(urethane)

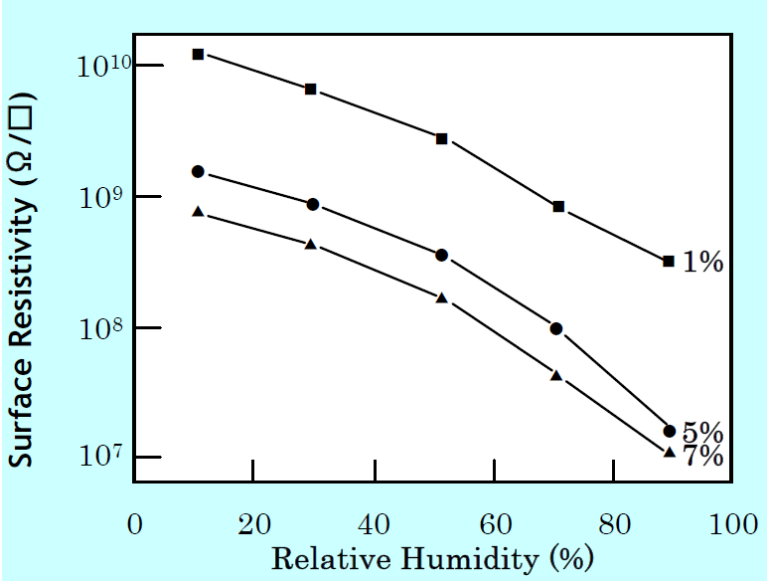

Fig. 2 Surface resistivity dependence of PEL 20A/poly(urethane) composite on relative humidity

PEL contents: 1, 5 and 7*wt*%

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4. Lineup of PELs

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	PEL-20A	PEL-100	PEL-25	PEL-46
appearance	transparent ~ pale yellowish liquid	transparent ~ pale yellowish liquid	transparent ~ pale yellowish liquid	pale yellowish liquid
salt	$LiClO_4$	$LiClO_4$	$LiClO_4/CF_3SO_3Li$	organic boron complex Li salt
salt content	10*wt*%	10*wt*%	15*wt*%	30*wt*%
matrix polymer	PEO-PPO copolymer	PPO	PEO-PPO copolymer	PEO-PPO copolymer
Mw of matrix polymer	~1300	~2000	~1300	~1300
hydroxyl number	~78	~57	~74	~58
characteristics	standard grade	better miscibility w/ hydrophobic polymer	more conductive than 20A	Halogen free relatively low conductive

* By making use of hydroxyl end groups in the matrix polymer, it is possible to fix the matrix polymer into counterpart of composite polymer *e.g.* poly(urethane) with a crosslinking agent such as isocyanate.

Polymer or resin	Miscibility w/ PEL
Poly(urethane), acrylic resin	○
Poly(ester), epoxy resin, PVC	△
PE, PP, PS and other hydro carbon polymer	△～×
PVDF	×
Silicone resin, styrene-acrylic resin	×

Legend
○: miscible
△: partially miscible
×: not miscible

6. Miscibility of PELs w/ various solvents

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solvent	PEL-20A	PEL-100	PEL-25	PEL-46
water	○	×	○	○
MeOH	○	○	○	○
EtOH	○	○	○	○
IPA	○	○	○	○
acetone	○	○	○	○
MEK	○	○	○	○
NMP	○	×	○	×
acetonitrile	○	○	○	○
EtOAc	○	○	○	○
BuOAc	○	○	○	○
propylene carbonate	○	○	○	○
m-xylene	○	○	×	○
toluene	○	○	○	○
hexane	×	×	×	×

① Polyurethane rubber
Urethane is cross linked after addition of 10～20*wt*% of PEL.
⇒ Surface resistance $10^{10}\Omega$（Volume resistance $10^{9}\Omega$/cm）

② Urethane acrylic coating
10*wt*% of PEL to the resin
⇒ The surface resistance $10^{10}\Omega$

③ Acrylic pressure sensitive adhesive
5～8*wt*% of PEL to the resin
⇒ The surface resistance $10^{11}\Omega$

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