Influence of elastic modulus of encapsulant on solder bond failure of c-Si PV modules

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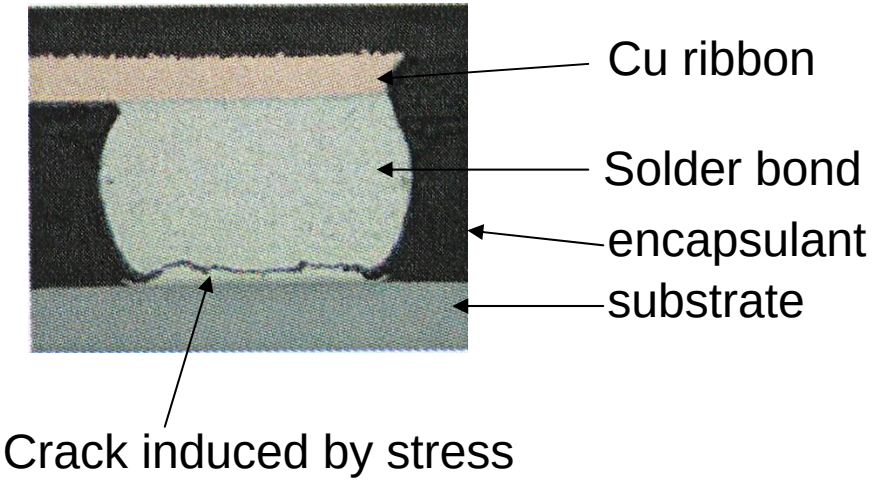
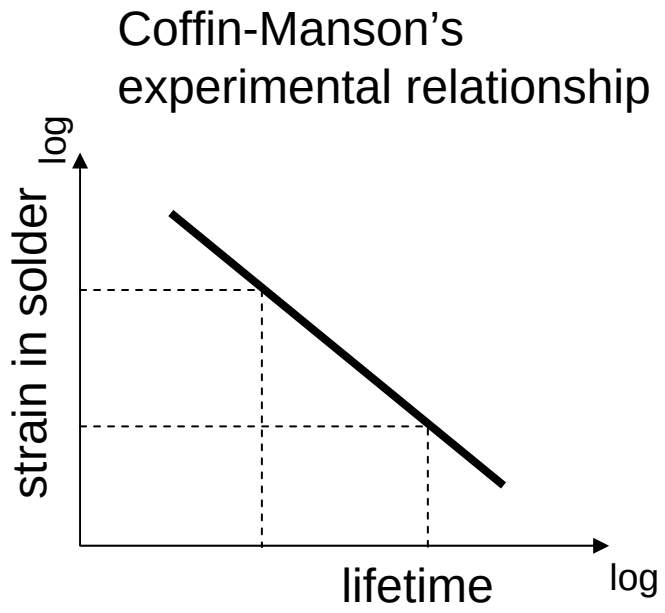
Solder bond failure

Our approach for lifetime prediction of solder bond failure





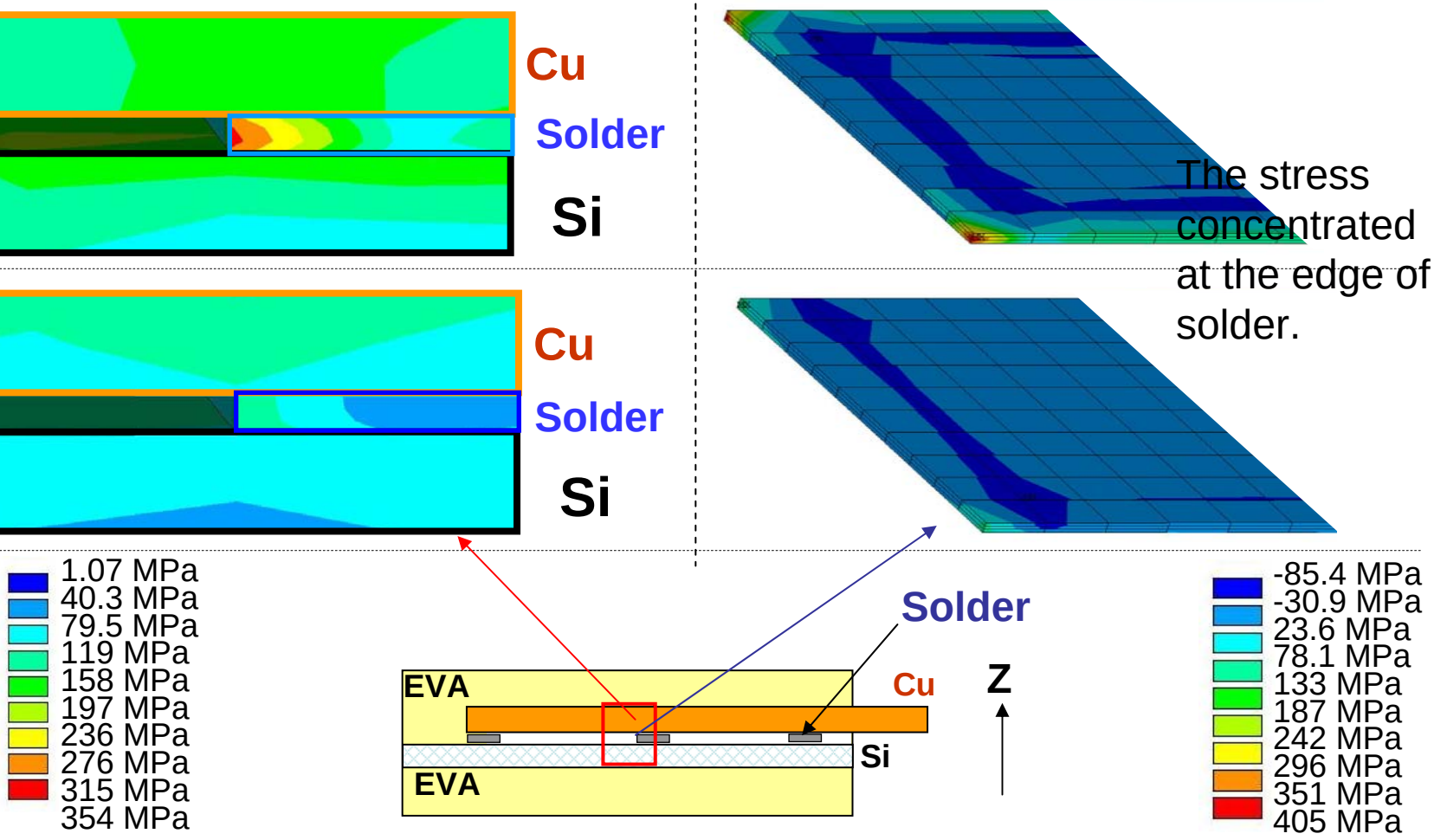
Low strain (stress) leads to long lifetime.

We have calculated stress distribution in solder changing elastic modulus of encapsulant by using finite element method (FEM).

Solder bond failure -simulation-

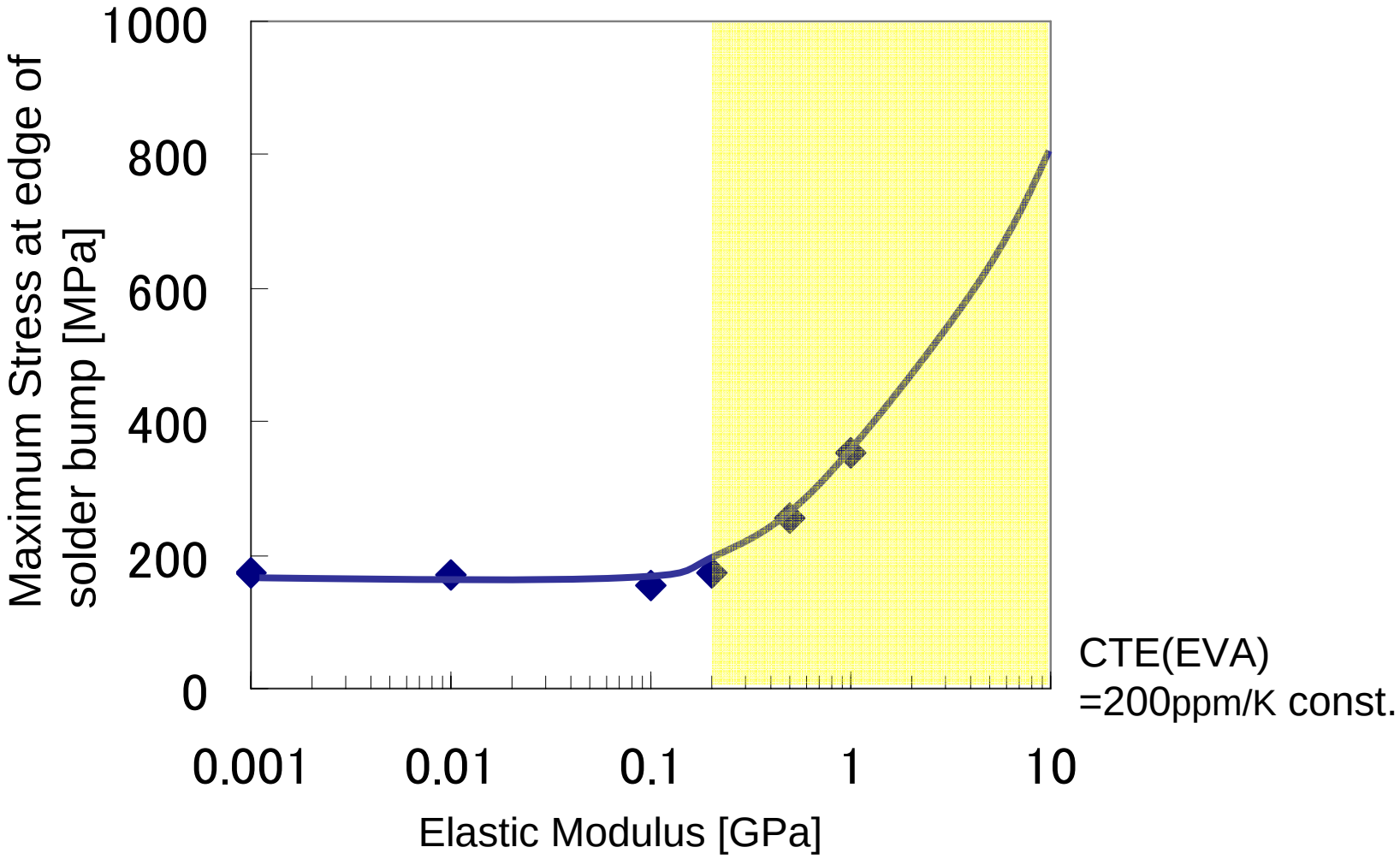
Mitsui Chemicals Group

Modulus	Stress distribution (z-axis)	Stress distribution (xy-plane)
1 GPa	Cu / Solder / Si	The stress concentrated at the edge of solder.
0.1 GPa	Cu / Solder / Si	



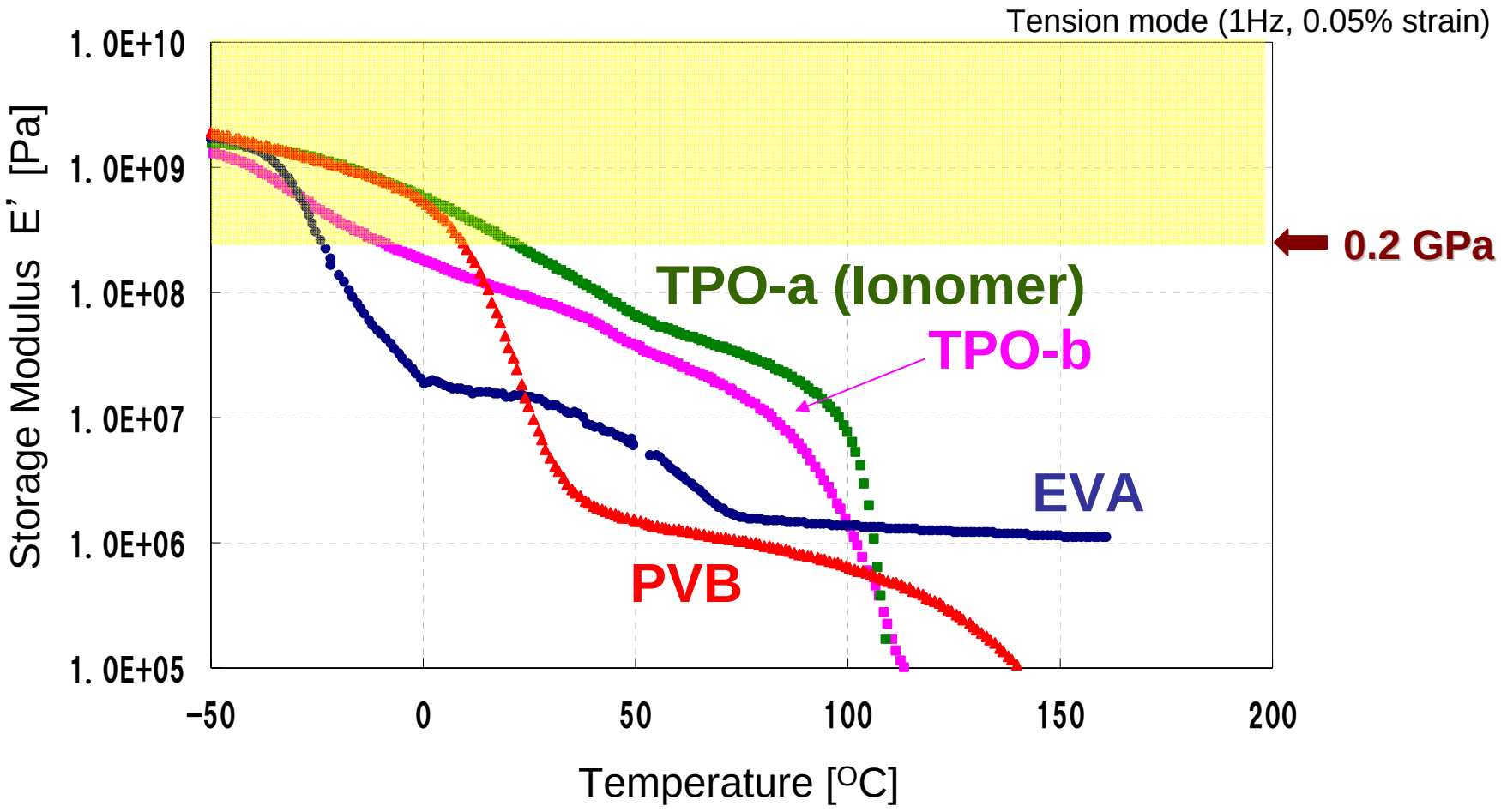
Stress due to thermal expansion of EVA increases with high modulus of EVA

Stress as a function of Elasticity



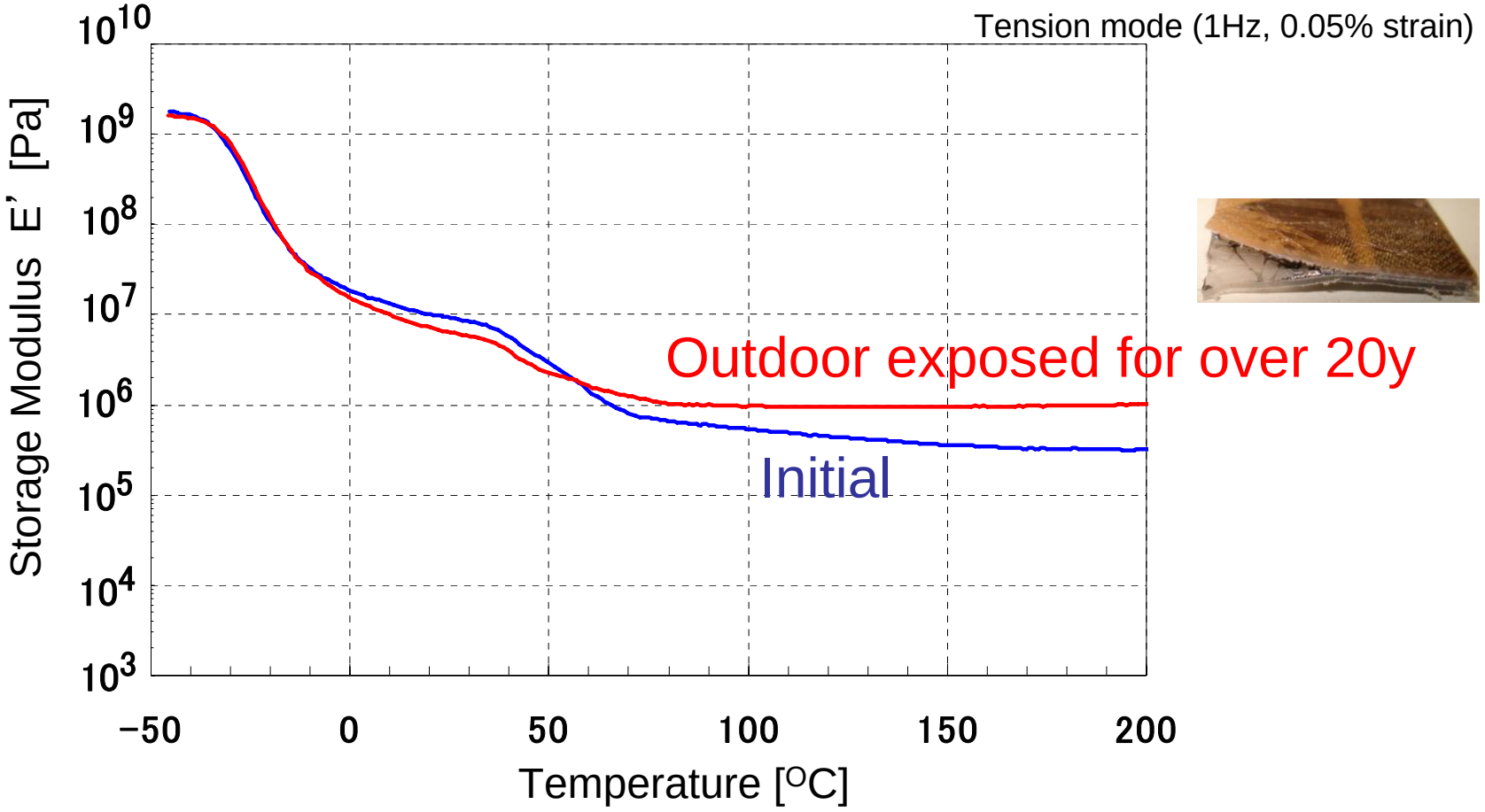
The elastic modulus >0.2 GPa of encapsulant leads to high stress at the solder bump.

Elastic modulus for several encapsulants



TPO-a has high elasticity >0.2 GPa at room temperature and high risk for solder bond failure, according to our simulation.

Change in elastic modulus of EVA sheet



There are no changes significantly in elastic modulus, caused by decomposition of EVA. This result indicates EVA encapsulant is reliable.

Summary

✓We estimated maximum stress at solder bond as a function of elastic modulus of encapsulant using FEM.

✓The elastic modulus >0.2 GPa of encapsulant leads to high stress at the solder bump.

✓TPO-a (Ionomer) has high elasticity >0.2 GPa at room temperature and high risk for solder bond failure, according to our simulation.

✓There are no changes significantly in elastic modulus, caused by decomposition of EVA. This result indicates EVA encapsulant is reliable.

✓We speculate that risk of cell-crack of c-Si cells in a PV module depends on elastic modulus of encapsulant as well as solder bond failure. To find out the trend is ongoing.