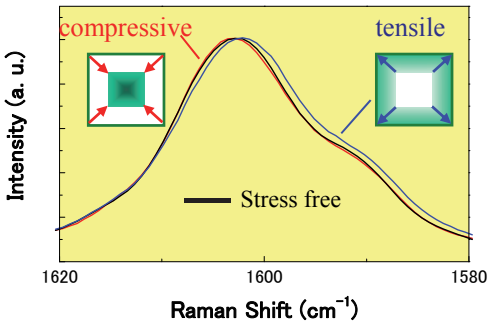
Determination of Stress Distribution in Polymeric Materials by Raman Spectroscopy

I -3

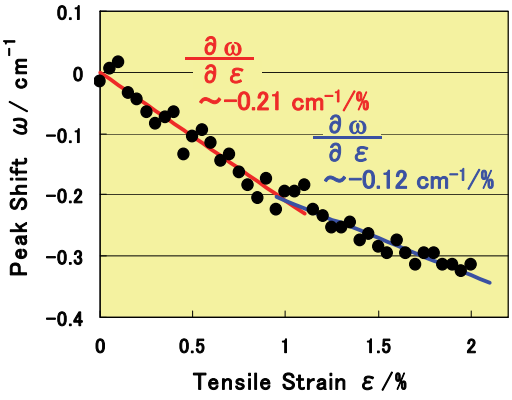
Linear correlation has been found between the applied stress and Raman band shift of Polycarbonate materials by 4-point bending test. The stress correlation coefficient has been successfully applied to determine the micron order stress distribution of the joined region in a small polymeric screw.

Determination of the correlation coefficient between induced stress and the Raman band shift

Stress induced band shift of polycarbonate

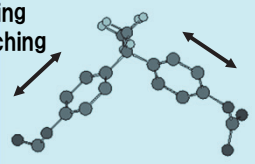


Correlation between band shift and tensile stress

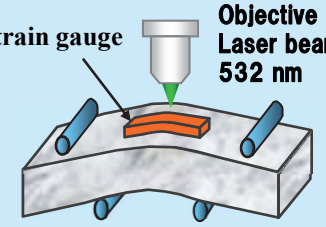


Resolution: 0.05 cm^{-1}
Detection limit of strain : 0.23 %
Detection limit of stress : 5.3 MPa
(elastic region E ~2.3 GPa)

Aromatic ring
C=C stretching



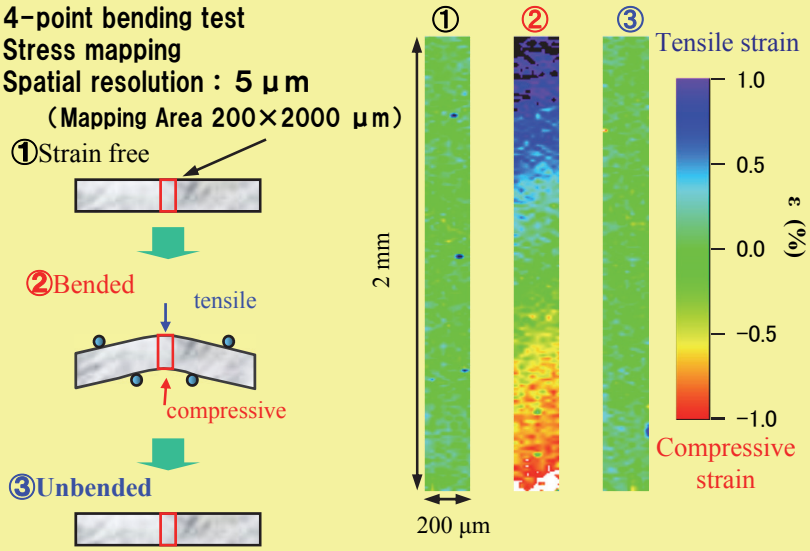
Sample : Polycarbonate (PC)
Thickness : 2 mm



4-point bending test

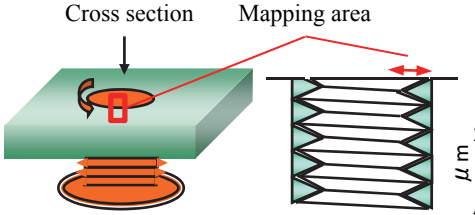
Stress distribution along the thickness direction

4-point bending test
Stress mapping
Spatial resolution : 5 μm
(Mapping Area 200×2000 μm)



Raman spectroscopy provides micrometer order stress distribution.

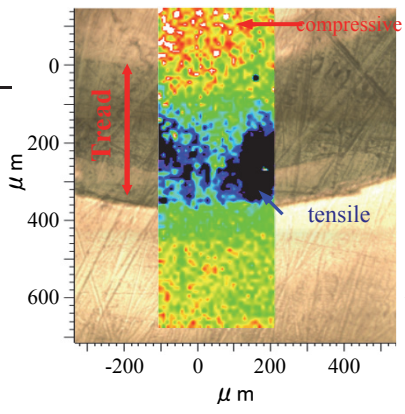
Stress distribution at the joined region of a small polymeric screw



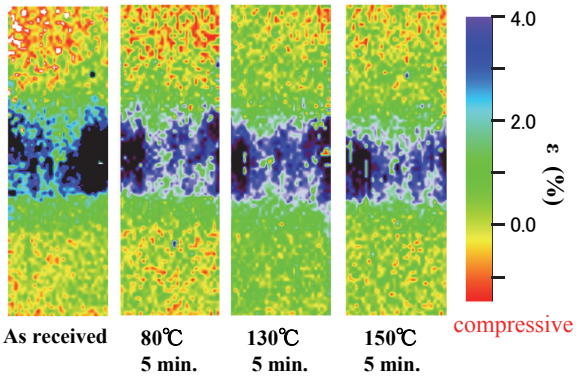
PC M3/PC board
Pitch 0.5 mm

Thread : tensile strain
Root of thread : compressive strain

Stress distribution
(On optical Microscope image)



Stress relaxation by annealing treatment



Stress relaxation induced by annealing can be clearly observed by Raman stress mapping.