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Deformation of polymer-metal laminates

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Introduction
In polymer-metal laminates the moduli and the plastic deformation behavior of both materials determine the overall behavior of the laminate upon loading. The mechanism by which the interface deforms is an interplay between the interaction potential and bulk properties of the individual materials.

Experimental approach
By altering the bulk properties of any one of the two materials and observing the changes and influence on the interface we can get a step closer in to understanding the role of the interface during laminate forming. Hence the polymer was annealed at various temperatures and the changes observed on
- the mechanical behaviour of the bulk polymer.
- crystallinity of the polymer.
- adhesion and deformation mechanism of the polymer on the laminate.

Methods and Observations
A: Mechanical behaviour of bulk polymer
PET was injection moulded and annealed at various temperatures as shown in Fig1, followed by compression and tensile loading.

B: Relative crystallinity of the polymer
The annealed bulk PET samples were studied using FT Infra-Red spectroscopy. The absorption band at 1409 cm\(^{-1}\) can be taken as a reference to normalize all spectra using 1343 cm\(^{-1}\) absorption band to determine the relative crystallinity of the samples.

C: Adhesion and deformation of polymer on the laminates
PET coated Electrochemically coated steel laminates were prepared by block coating polymer solution on the steel substrate and cutting into micro tensile bars. PET-steel laminates were again annealed and quenched. These annealed laminates were then loaded in tension using the Deben Micro-Tensile tester and observed in situ with the optical microscope under cross polarized light.

Conclusions
- Mechanical behaviour of PET can be influenced by annealing it above its cold crystallization temperature (\(T_{cc}=120^\circ C\)).
- Although annealing improved the mechanical properties of the bulk polymer, it lead to weakening in polymer-metal bonding.
- Higher annealing temperatures lead to poorer bonding.
- Bonding layer directly in contact with the metal should be amorphous as crystalline coating delaminates from metal on loading.