Inverse Problems Network Meeting 5

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University of Kent

Abstract of Talk

INVERSE PROBLEMS IN MODELLING CREEP AND RELAXATION OF POLYMERIC MATERIALS

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Most materials encountered in everyday life are viscoelastic in nature. Examples include plastics, composites, foods, biological fluids, oils, paints and gels, all of which are polymeric or biopolymeric. Both viscous and elastic properties pertain in these materials, and when subjected to an applied force the resulting deformation is a combination of viscous response and elastic response. There exist many constitutive models which describe the time-dependent relationships between stress and strain in deformations and flows of such materials. These models can be of differential or integral type, and can portray various degrees of complexity in the materials represented.

In all models, however complex, there is present a key material function, $\mathcal{G}(t)$ which is the relaxation modulus of the material. $\mathcal{G}(t)$ is normally modelled as the Laplace transform of a positive measure, and as such is an example of a completely monotonic function. Another important material function is the creep compliance $\mathcal{J}(t)$, the derivative of which is also completely monotonic. $\mathcal{G}(t)$ and $\mathcal{J}(t)$, are related by the Volterra integral equation

$$\int_0^t \mathcal{G}(t-t')\mathcal{J}(t')dt' = t,\ t \geq 0$$

In principle, $\mathcal{G}$ can be found from a relaxation experiment, while $\mathcal{J}$ can be found from a creep experiment, although it is usually not possible to perform both experiments on the same material. In this talk it is shown how the two functions can be determined simultaneously from a single experiment. The analysis highlights a system of embedded inverse problems.