

GARField Magnetic Resonance Profiling across a Photo-Initiated Cross-Linking Latex Coating

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Magnetic resonance imaging is now the imaging modality of choice for a wide range of medical diagnoses involving soft tissue. It is also finding increasing application as a powerful characterisation tool in engineering and materials science, notably for studies of liquids in porous media and of soft condensed matter. The method can be both non-invasive and non-destructive allowing temporal studies to be carried out. Moreover, a wide range of contrast filters can be applied based on coherent (flow) and incoherent (diffusive) transport and on molecular reorientation. These and other advantages more than compensate for the relatively low spatial resolution and relatively high cost of the necessary technology. However, even these disadvantages are diminishing.

At the University of Surrey, we have recently designed and had built a novel permanent bench-top magnet called GARField, standing for Gradient At Right-angles to Field (P. Glover *et al.* *J. Magn. Reson.*, **139** 90, 1999). The magnet has shaped pole pieces which yield a near horizontal magnetic field of constant magnitude in the horizontal plane together with a strong field gradient in the vertical direction. Coupled to a standard low-cost, low-frequency, bench-top NMR spectrometer, this new magnet allows us to perform high spatial resolution profiling through planar samples at modest cost without seriously compromising one-dimensional performance. The profiles provide information about the concentration of mobile protons and their molecular mobility (via the relaxation time, T_2). GARField is thus an ideal tool for probing a wide range of phenomena in polymer films and coatings, including water loss, crosslinking, plasticisation, and solvent ingress or egress.

In this talk, I will introduce magnetic resonance imaging in general and go on to explain the design philosophy of GARField. I will then describe one of our first major studies using it: an examination of drying and film formation in a photo-initiated cross-linking latex coating based on a vinyl acetate / ethylene copolymer with a reactive aceto-acetoxy functionality (M. Wallin *et al.* *Macromolecules*, **33** 8443, 2000). Magnetic resonance profiles with a resolution of the order of 10 μm through samples typically 200 μm thick reveal that cross linking occurs first in the central layers of the coating and not at the air or substrate interfaces, figure 1. A simple numerical model which includes the combined effects of evaporation, light penetration and oxygen inhibition of polymerisation has been developed to explain the results.

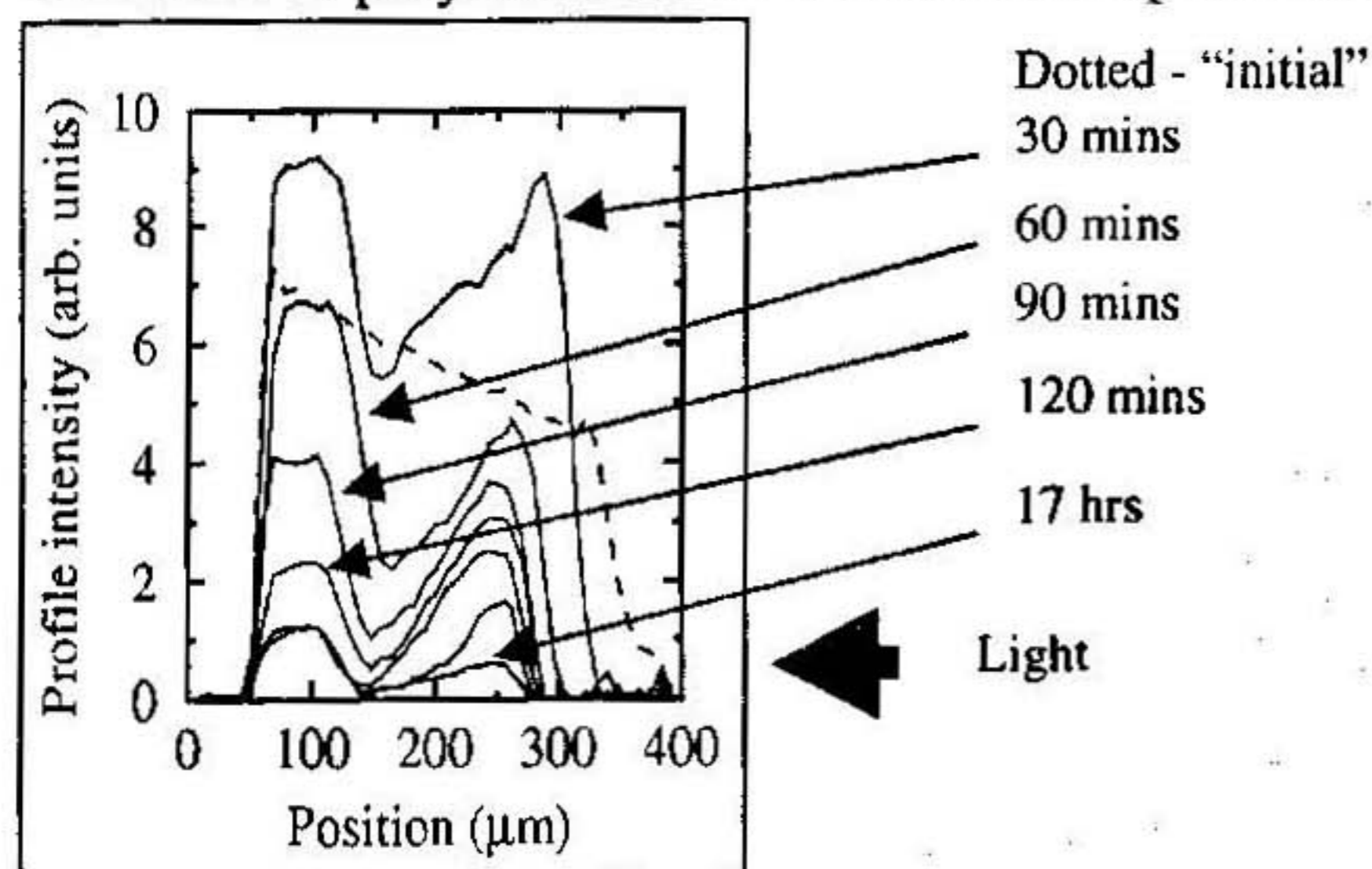


Figure 1. GARField profiles through the complete latex formulation as it dries and cross links.