

# The comparison of alkyd drying using alternatives for cobalt driers; comparing NMR imaging and conventional methods

S.J.F. Erich<sup>1,2</sup>, Ö. Gezici<sup>1</sup>, C.A.A.M. Thomas<sup>1,3</sup>, M.B. Michel<sup>1,3</sup>, H.P. Huinink<sup>1</sup>, O.C.G. Adan<sup>1,2</sup>,

Jitte Flapper<sup>3</sup>, Francis Duivenvoorde<sup>3</sup>, and L.G.J. van der Ven<sup>3</sup>

<sup>1</sup> *Department of Applied Physics, Eindhoven University of Technology,*

*P.O. Box 513, 5600 MB Eindhoven, the Netherlands*

<sup>2</sup> *TNO, P.O. Box 49, 2600 AA Delft, the Netherlands*

<sup>3</sup> *AkzoNobel Coatings, 2170 BA Sassenheim, the Netherlands*

*Corresponding author: S.J.F.Erich@tue.nl*

**Keywords:** coating, alkyd, crosslinking, primary driers, metal catalyst, magnetic resonance imaging,

As a result of the potential changes in classification of cobalt based driers, many studies have been conducted to find suitable alternatives in alkyd paints. Some replacements are relatively successful and are used commercially. For the first time, a systematic investigation on the oxidative drying of solventborne alkyd coatings under the influence of promising commercial cobalt alternatives was performed including NMR imaging as a method. Besides using cobalt based drier, Co-10, as a reference, the alkyd compositions were prepared in the presence of an iron based drier (BOC, Borch OXY-Coat) and two manganese based driers (DriCAT 2700F and Nuodex Drycoat) with their suggested concentrations to provide optimum efficiency.

The present work investigates how these commercial driers influence the drying behavior (homogeneous or front like) and the molecular network development and mechanical properties of the dried films. Besides high spatial resolution NMR imaging and time-resolved ATR-FTIR, and conventional techniques like BK drying test, König hardness and DMA were used. NMR imaging is a powerful technique which allows following the depth-resolved reduction of mobility during the drying process (including solvent evaporation and curing). Complementary techniques, like the BK drying test, reveals information of the uppermost layer of the alkyd film, while ATR-FTIR follows the chemical changes and cross-link formation at the substrate side of the film. DMA was used to determine the glass transition temperature ( $T_g$ ) and the crosslink density of the films.

During the drying in presence of cobalt a front is formed, which indicates that the limiting process during the drying is the oxygen penetration to the cross-linking front. A more uniform crosslinking was achieved by cobalt alternatives (BOC, Dricat and Drycoat), which was largely shown to be “homogeneous” drying. The iron based drier showed the fastest drying rate. Furthermore, the Dricat and Drycoat (both manganese based driers) showed an induction period. For cobalt alternatives, the final crosslink density and the hardness development are comparable, and are less cross-linked than the films with cobalt. We found a clear relationship between drying times, NMR relaxivity ( $T_2$ ), glass transition temperatures ( $T_g$ ), hardness and cross-linked density for the different driers.