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Shedding New Light on Polyurethane Degradation: Assessing foams condition in design objects

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ABSTRACT

A new insight into the degradation of polyurethane (PUR) slabstock foams is suggested by studying historical design objects and PUR references submitted to natural ageing. PUR foams are segregated structures comprising hard and soft domains, as well as chemical and physical crosslinking (H-bonds). H-bonds have been commonly followed in polymerisation studies of PUR foams by monitoring carbonyl bands in the infrared. Their fundamental role in PUR physical properties has been stressed; however, their liability to natural ageing has been poorly focused, with few studies suggesting their vulnerability to high temperature and humidity. As PUR has a short lifespan, and many objects show severe degradation signs (yellowing, crumbling and brittleness), the in-depth analysis of PUR foams behaviour upon natural ageing, as well as the monitoring of H-bonds over these processes is discussed in this paper. References of PUR slabstock foams (ether-based polyols and toluene diisocyanates) were produced; and infrared micro-spectroscopy and optical microscopy (under darkfield, polarised light and UV light) were selected to assess PUR ageing. A visual (micro level) and molecular pathway for PUR natural ageing is suggested, and deterioration signs (yellowing, micro holes, pitting and cracks) on PUR cell buns were translated into specific infrared fingerprints (assigned to N–H, C–H and C=O stretching absorptions). As the C=O band at c. 1640 cm^{-1} (indicator of PUR hard domain ordered structure) showed considerable changes upon PUR ageing, this study confirms