"*Trigger*" Mechanisms of Ultra-Fast Reactions

Daniel P. Riley, Erich H. Kisi, Caroline Curfs, *School of Engineering, The University of Newcastle, NSW 2318, Australia*. E-mail: Daniel.Riley@newcastle.edu.au

While it is well established that rates of reaction will diverge for chemically homogeneous systems during increased heating [1], most solid state materials synthesis involves inhomogeneous mixtures of discrete particles that limit reaction rates by the need for interparticle diffusion. *In-situ* diffraction is a well established technique for the time-resolved analysis of such reactions. We present recent data that demonstrates the importance of several fundamental "*trigger*" mechanisms for initiating ultra-fast, self-sustaining reactions. These trigger mechanisms rely on phenomena which provides a discontinuity in the relative diffusivity of key reactants. Important examples of these experimental observations include the $\alpha \rightarrow \beta$ transition in titanium (~920^{o}C), which influences the solid-solid combustion reaction (SHS) of several systems (e.g. Ti_3SiC_2 [2] and Ti_5Si_3 [3]), and the *solid* $\rightarrow$ *liquid* state transition of aluminium (~660^{o}C), verified to be the initiating mechanism for other SHS reactions. In addition, the influence of these trigger mechanisms on slower processing techniques (e.g. sintering) can explain why higher order systems may not completely react. By understanding these mechanisms and how they influence reaction dynamics, processing can be optimised. Central to this is the continued development of *in-situ* diffraction.

[1] Lacey A.A., *Proc. R. Soc. Lond. A*, 1992, 145-152. [2] Riley D.P., Kisi E.H., Hansen T.C., Hewat A.W., *J. Am. Cer. Soc*., 2002, **85**, 2417-2424. [3] Riley D.P., Oliver C.P., Kisi E.H., "In-situ Neutron Diffraction of Titanium Silicide, Ti_5Si_3, during Self-Propagating High-Temperature Synthesis (SHS)", *Accepted Intermetallics 2005*.

Keywords: *in-situ* diffraction, reaction mechanisms, kinetics