Exploring Alternative Mechanisms and Pathways in Sonochemistry

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Most scientists involved in sonochemistry believe that sonochemical effects are linked with acoustic cavitation. This is true for a very wide range of what we might think of as "main stream" sonochemistry and stems from the absolutely correct statement that "*sonochemical effects occur at frequencies and wavelengths of ultrasound that are not of molecular dimensions"*.

In the early history of sonochemistry the name of Jean-Louis Luche is prominent and it was he that in 1990 used electron transfers in his attempts to divide sonochemical reactions into two classes which he defined as "true" and "false" (1, 2). In his eyes TRUE sonochemical reactions were those which involved electron movement and corresponded to processes in which the production of the reactive intermediate, a radical or a radical-ion, was stimulated by irradiation with ultrasound. On the other hand, FALSE sonochemical reactions were those in which only the mechanical and physical effects of sonic waves were involved. Electron transfers are involved in ***the sonochemical switch*** of a reaction pathway identified in 1994 by Takashi Ando (3) and many examples have appeared since (4-7). Such switching in product formation, dependent upon the presence of ultrasound, is difficult to explain without taking into account the possibility of electron transfer, which can be inner- or outer-sphere (8, 9). However, there are some sonochemical effects induced by ultrasound which are not so obviously associated with acoustic cavitation but could still involve electron transfer. In a paper published this year we began to explore such effects using concepts based upon a transient ordering of molecules within a sonicated liquid induced by the compression phase of acoustic waves as they passed through (10). In the solid-like structure induced by such an ordering effect it is possible to develop electrical charges that could facilitate intermolecular electron movement that might then induce chemical reactions. Such reactions could occur in the absence of cavitation by the pressure fluctuations of the sound wave itself or, in circumstances where cavitation does occur, through transient solid-like phases produced by the shockwave accompanying bubble collapse. Whilst we admit that these ideas may not be immediately accepted by sonochemists we would like to emphasize that we recognize that sonochemistry is driven mainly by cavitation and we are only seeking to explain some seemingly anomalous findings. In this presentation we will explore other examples of reactions that could be attributed to the "*ordering effect*".

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