

Experimental report

15/02/2017

Proposal: 9-13-632

Council: 4/2016

Title: Photo-induced polymerization of dental materials

Research area: Materials

This proposal is a new proposal

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Samples: resin-modified glass ionomer cement (RMGIC)

Instrument	Requested days	Allocated days	From	To
IN16B	4	2	26/09/2016	28/09/2016

Abstract:

Despite the improvements in preventive measures, dental cavities remain a major public health problem. One material to fill teeth affected by cavities is resin-modified glass ionomer cement (RMGIC), which undergoes a polymerization reaction upon light illumination. Proper polymerization of the resin component is vital to achieve the necessary strength of the filling. To fully understand this process, it is important to understand how the photo-initiation affects proton mobility in RMGICs. Therefore, we propose to measure QENS spectra of a specific RMGIC (Hema) as well as of its liquid precursor (liquid Hema) in the dark and after photo-illumination, respectively, on the backscattering spectrometer IN16b.

Dynamical behavior of LH2 membranes under pressure

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Despite the improvements in preventive measures, dental cavities remain a major public health problem. In order to fill teeth affected by cavities, different materials can be used. Since the Minamata Convention on Mercury, however, there is need either for the development of new alternatives or the improvement of existing mercury-free materials. Within this perspective, tooth-colored materials such as glass ionomer cements (GIC) are of interest. These water-based cements are biocompatible, bond to moist tooth tissues, and release fluoride. Nevertheless, one of the main drawbacks of GIC is their limited strength. The incorporation of a resin component to conventional glass ionomer cements (CGIC) is one strategy used to strengthen such material. Resin-modified glass ionomer cements (RMGIC) have longer working time, improved aesthetics, a rapid initial setting and enhanced initial strength when compared to CGIC.¹ However, in RMGIC the inclusion of the resin component makes the setting reaction more complex. In this material both (i) an acid-base reaction between the glass particles and the polyacid solution and (ii) a polymerization reaction of the resin monomers (i.e. hydrophylic methacrylates) induced by photo-initiation occur. Since a percentage of the water in RMGIC is replaced by resin monomers (in variable amounts depending on the commercial product), the initial setting is due to the rapidly occurring polymer chain propagation as a result of the polymerization reaction. As a result, a significant improvement in the strength of RMGIC during the critical first hours of setting is observed when compared to CGIC. It is generally accepted that during the early RMGIC setting process, the acid-base and polymerization reactions compete and inhibit each other.² Thus, proper polymerization of the resin component is vital to avoid RMGIC setting too slowly and consequently becoming weaker than a CGIC. To fully understand these limitations, there is a clear need to **understand how the photo-initiation affects proton mobility in RMGIC.**

The thermal behavior of two commercial liquids provided by Voco GmbH (Germany) were studied using the elastic fixed window approach at the backscattering instrument IN10 at the ILL without modification or light activation.³ One liquid contains an aqueous solution of polyacrylic acid (hereafter referred to as Liquid Poly) and the other a polyacrylic acid aqueous solution containing different methacrylates, mainly 2-hydroxyethyl methacrylate (hereafter referred to as Liquid Hema). In the later case the methacrylates partly replace the water. The first solution is used to prepare a CGIC (Ionofil Molar AC, hereafter referred to as Poly), while the second to prepare a RMGIC (Ionolux AC, hereafter referred to as Hema). From such analysis it was concluded that that these liquids present distinct dynamics which influence and to a certain extend control hydrogen binding to the GIC structure. However due to the limited flux of the instrument the diffusion coefficient of the liquids could not be extracted.

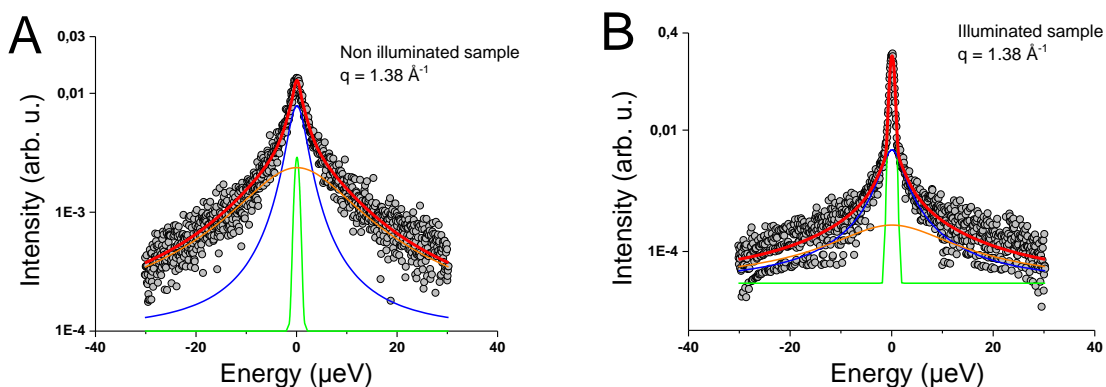


Figure 1. Fit examples.

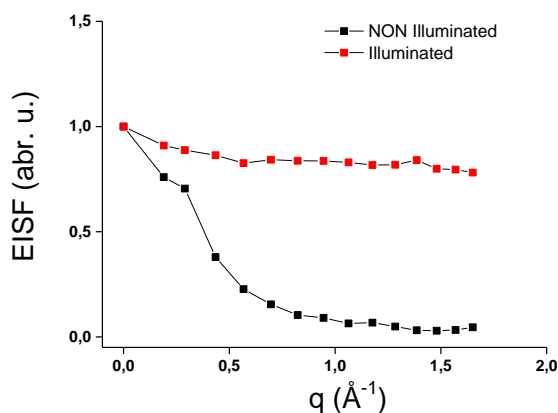


Figure 2. EISF comparison for NON illuminated and illuminated samples.

On IN 16B, Liquid Hema was measured without and with light activation, see Fig. 1. The QENS spectra were normalized to vanadium scan and converted to energy scale using LAMP. The scattering of empty cell was subtracted as a background scattering. The resulting QENS spectra were analyzed as a sum Gaussian peak and two Lorentzian peaks. The full widths of Lorentz peaks were kept constant at 3.7 μeV and 21 μeV . The resulting EISFs are shown in Fig. 2 and reveal a pronounced suppression of dynamics after solidification upon light excitation. A more detailed data analysis is in progress.

¹ Saito, S, Tosaki, S, Hirota, K, Advances in Glass Ionomer Cements (Davidson C.L., Mjr I.A., Eds.; Quintessence Publishing Co, Berlin, Germany, 1999) 15-50

² Villat C, Tran XV, Pradelle-Plasse N, Ponthiaux P, Wenger F, Grosogeat B, Colon P, Dent Mater 26 (2010) 127-132

³ M.C. Berg et al., submitted for publication