New barium titanate based dielectric materials for high field imaging

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Introduction. The use of suspensions of high dielectric materials to improve brain imaging and spectroscopy at 7 T has recently been described [1,2]. Calcium titanates suspensions can be produced up to a 40% v/v ratio in protonated or deuterated water with an \( \varepsilon_r \sim 110 \). For certain applications, higher values of \( \varepsilon_r \) would be desirable. Here we use barium titanates to reach values of higher than 200. One disadvantage of barium titanate is that it cannot reach a high v/v ratio; however, the use of chemical dispersants can increase this to give \( \varepsilon_r \) values higher than 300. Images acquired at 7 T show significantly increased transmit field strength close to the dielectric material.

Methods. Barium titanate suspensions of different concentrations were prepared, and the dielectric constant was measured using dielectric probe kit and S11 measurements. Darvan 821-A (ammonium polyacrylate) was used as a chemical dispersing to increase the maximum v/v ratio. A pad (15 x 10 cm) containing a suspension of \( \sim 25\% \) v/v barium titanate in water was prepared and sealed, and placed behind the head of a volunteer. T1-weighted scans and three dimensional B1+ maps were acquired to determine the effect of the dielectric material.

Results. Figure 1 shows that the maximum v/v ratio of barium titanate in water without dispersant is \( \sim 25\% \) giving and \( \varepsilon_r \sim 180 \). With the addition of Darvan the \( \varepsilon_r \) can reach 300, accompanied by a slight increase in loss tangent.

Discussion. This work shows the first characterization and application of materials with dielectric constants significantly above 200 to human studies. Strong increases in local B-fields can be induced, which can be used to counteract the intrinsic loss of transmit efficiency in certain areas of the brain at high field. This increase in local signal is accompanied by a slight decrease in global signal throughout the rest of the brain.