Preparation, characterisation and microwave dielectric properties of Ba(B′1/2Nb1/2)O3
[B′ = La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Y, Yb and In] ceramics

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Abstract

Microwave dielectric resonators (DRs) based on Ba(B′1/2Nb1/2)O3 [B′ = La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Y, Yb, and In] complex perovskites have been prepared by conventional solid state ceramic route. The dielectric properties (relative permittivity, εr, quality factor, Q, and resonant frequency, f) of the ceramics have been measured in the frequency range 4–6 GHz using resonance methods. The resonators have relatively high dielectric constant in the range 36–45, high quality factor and small temperature variation of resonant frequency. The dielectric properties are found to depend on the tolerance factor (t), ionic radius (r), and lattice parameter (a0).

Keywords: Dielectric resonators; Complex perovskites; Double perovskites; Microwave ceramics; Dielectric ceramics

1. Introduction

Dielectric resonators (DRs) are ceramics with high relative permittivity (εr), low dielectric loss (or high quality factor, Q), and small temperature variation of resonant frequency (f) that are used in place of bulky cavity resonators and lossy stripline resonators in modern microwave integrated circuits for reducing the size and weight of the components [1,2]. Typically, ceramics with 20 < εr < 100, Q > 2000, and τf < 20 ppm/°C are useful for various kinds of applications ranging from 800 MHz (UHF) to 20 GHz (K band) of microwave spectrum. This limits the number of materials available for practical applications. The important dielectric resonator materials so far studied include Ba2Ti5O12 [3], ZrSnTiO4 [4], BaO-Ln2O3-Sc2O3 [5,6] (Ln = rare earth), Ba3Nb2O7 [7] and complex perovskites [8,9]. Still the search for new ceramics with better characteristics is in progress.

Several workers [8–12] investigated the dielectric resonator properties of A(B′1/3B′′1/3)2O3 ceramics where A = Ba, Sr, B′′ = Zn, Mg; and B′′′ = Nb, Ta. Although a considerable amount of work has been done on the A(B′1/2B′′′)3O3 perovskites, only a little attention has been paid to the microwave dielectric properties of A(B′1/2B′′′)3O3 type complex perovskite ceramics where B′′′ is a trivalent ion and B′′′′ is a pentavalent ion. Agranovskaya [13] in 1960 outlined the dielectric properties of A(B′1/3B′′′1/3)2O3 complex perovskites. A detailed description about the structure and properties of a large number of this type of compounds is given by Galasso [14]. Takata and Kageyama [15] were the first to investigate the microwave dielectric properties of A(B′1/2B′′′1/2)2O3 type perovskites (A = Ba, Sr, Ca; B′′′ = La, Nd, Sm, Yb, and B′′′′ = Nb, Ta). They obtained εr in the range 30–45 and found that niobates and tantalates of Ba have positive τf while those of Sr and Ca have negative τf. Recently, several authors [16–20] reported the microwave dielectric properties of a few of the A(B′1/2B′′′1/2)3O3 type ceramics by direct microwave or spectroscopic methods. It was reported that the εr value of Ba(Nd1/2Nb1/2)O3, Ba(Sm1/2Nb1/2)O3, Ba(Eu1/2Nb1/2)O3, and Ba(Pr1/2Nb1/2)O3 as 12, 9, 11,
and 15, respectively, in the microwave frequency region
[20] which were different from the report of Ikawa and
Takemoto [21], and Zurmuhlen et al. [17]. Since the di-
electric constants reported by various research groups
[15–17,19,20] on some of the A(B′₂Nb₁₂)O₃ com-
ounds are found to be contradicting, we have under-
taken a detailed study on the preparation, characterization
and microwave dielectric properties of Ba(B′₂Nb₁₂)O₃
[B′ = La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Yb, and In] cera-
amics.

2. Experimental

The ceramic resonators Ba(B′₂Nb₁₂)O₃ [B′ = La, Pr,
Nd, Sm, Eu, Gd, Tb, Dy, Ho, Yb, and In] were pre-
bred by the conventional solid state ceramic route. Start-
ing materials were high purity BaCO₃ (Aldrich Chem-
icals; 99.9%), Nb₂O₅ (Nuclear Fuel Complex, Hyderabad;
99.9%) and rare earth oxides (Indian Rare Earths Ltd.;
99.9%). The powders were ball milled using distilled
to water for 36 h. The slurry was then dried and calcined
in platinum crucibles at temperature 1375 °C for 4 h. Af-
ter an intermediate grinding the powders were recalci-
ted at the same temperature for the same duration and again
ground well. The calcined powders were ground for 2 h
in an agate mortar to get fine powders and mixed thor-
oughly with 4 wt.% PVA solution. The slurry was dried and
uniaxially pressed into cylindrical compacts of 11–14 mm
diameter under a pressure of about 150 MPa. The green
compacts were initially fired at a rate of 6 °C/min up to
800 °C and then at a rate of 12 °C/min to the sintering
temperature. An intermediate soaking at 800 °C for 30 min
was given to expel the binder (PVA). The sintering tem-
peratures of the different Ba(B′₂Nb₁₂)O₃ compounds
were in the range 1575–1600 °C for 4 h in air. The mate-
rials with tolerance factor, t > 0.98 were found to have poor
sinterability. Materials with t > 0.98 were sintered with
the use of 0.5–1 wt.% of CeO₂, as sintering aid, which
was added to the calcined powder. In the case of
BaIn₀.₂Nb₁₂O₃ ceramic La₂O₃ or MoO₃ was used as
sintering aid. Ba(B′₂Nb₁₂)O₃ materials whose tolerance
factor t < 0.98 were sintered well without any sintering
aid. The bulk densities (D) of the sintered samples were mea-
sured by Archimedes method. Well polished samples were
used for microwave measurements and powders of sintered
specimens were used for recording X-ray diffraction (XRD)

definitions.

The microwave dielectric properties of the samples were mea-
sured using HP8510C Network Analyzer. The dielectric
constant was obtained by the Hakki and Coleman method
[22] using TEO₁₁ mode. Quality factor was calculated from
TEO₁₁ mode by the cavity method [23]. The temperature
variation of the resonant frequency was obtained by heating
the sample and noting the variation of the resonant frequency (f₀) at
different temperatures.

3. Results and discussion

The Ba(B′₂Nb₁₂)O₃ ceramics with t > 0.98 when fired without additive,
showed a very poor sinterability and did not show any sign
of sintered appearance, shrinkage or mechanical strength,
even after firing at 1650 °C for 4 h. The tolerance factor was
calculated using the following equation [24] modified for
Ba(B′₂Nb₁₂)O₃ complex perovskite,

\[ t = \frac{r_{Ba} + r_{Nb} + \frac{1}{2}r_{O}}{\sqrt{2}} \]  \( t > 0.98 \)  \( t > 0.98 \)  \( t > 0.98 \)  \( t > 0.98 \)  \( t > 0.98 \)

where \( r_{Ba}, r_{Nb}, \) and \( r_{O} \) are the ionic radii of the constituent
ions [25].

The percentage densities of the ceramics with t ≥ 0.98
though fired at 1650 °C were very poor (see Table 1).
But addition of 0.5–1 wt.% of CeO₂ [1 wt.% of La₂O₃ or
0.5 wt.% MoO₃] in the case of BaIn₀.₂Nb₁₂O₃ to the
calcined powders, reduced the sintering temperature to
1575–1600 °C and enhanced the sintered density to 96–98% of
the theoretical density with a corresponding improvement
in their microwave dielectric properties. The percentage
density of materials having tolerance factor, t < 0.98 were
in the range 97–98% without using sintering aid except for
Ba(Gd₁₀.₂Nb₁₂)O₃ ceramics. A comparison of measured
density (Dₐ) and theoretical density (Dₜ) against ionic
radii are given in Fig. 1. The density decreases with the
increase of ionic radii. However, the behaviors of Y and In
are different and is due to the fact that they do not belong
to the lanthanide group. It may be noted that the theore-
tical density is calculated assuming cubic symmetry.
The perovskite cell parameter (a₀) in terms of the ionic radii of
the ions forming a perfect cube was calculated using the
following equation [24,25]

\[ a₀ = \frac{r_{Ba} + r_{Nb} + \frac{1}{2}r_{O}}{\sqrt{2}} \]  \( a₀ = \frac{r_{Ba} + r_{Nb} + \frac{1}{2}r_{O}}{\sqrt{2}} \)  \( a₀ = \frac{r_{Ba} + r_{Nb} + \frac{1}{2}r_{O}}{\sqrt{2}} \)  \( a₀ = \frac{r_{Ba} + r_{Nb} + \frac{1}{2}r_{O}}{\sqrt{2}} \)  \( a₀ = \frac{r_{Ba} + r_{Nb} + \frac{1}{2}r_{O}}{\sqrt{2}} \)

The equation assumes the unit cell as an ideal cube. The
ionic radii are taken from Shannon [25] for the appropri-
ate co-ordination numbers. The addition of sintering aid
improves the densification by solid solution effect [26].

To understand the effect of CeO₂, we studied five differ-
ent compositions of Ba(In₀.₂Nb₁₂)O₃ with 0.5, 1, 2, 5, and

<table>
<thead>
<tr>
<th>B’ element</th>
<th>Percentage density (without sintering aid)</th>
<th>Percentage density (with sintering aid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho</td>
<td>76</td>
<td>96</td>
</tr>
<tr>
<td>Yb</td>
<td>60</td>
<td>98</td>
</tr>
<tr>
<td>Y</td>
<td>74</td>
<td>96</td>
</tr>
<tr>
<td>Ho</td>
<td>76</td>
<td>97</td>
</tr>
<tr>
<td>Dy</td>
<td>77</td>
<td>96</td>
</tr>
<tr>
<td>Tb</td>
<td>92</td>
<td>98</td>
</tr>
</tbody>
</table>

Table 1 Variation of percentage density of Ba(B′₂Nb₁₂)O₃ ceramics having t > 0.98 with and without the sintering aid
Variation of theoretical density \( (D_T) \) and measured density \( (D_M) \) of \( \text{Ba}\left(\text{B}^{1/2}\text{Nb}^{1/2}\right)\text{O}_3 \) ceramics with ionic radius of \( \text{B}^{1/2} \) ion. \( D_T \) was calculated assuming the cubic symmetry.

10 wt.% of CeO\(_2\) as a sintering aid. Variations of the dielectric constant \( (\varepsilon_r) \) and the normalized \( Q \) factor \( (Q_{xf}) \) with the addition of CeO\(_2\) in different wt.% are shown in Fig. 2. It can be seen that the addition of CeO\(_2\) decreases the \( \varepsilon_r \) and \( Q \) factor in the microwave frequency range. But the bulk density and temperature coefficient of resonant frequency of these samples did not show any significant variation beyond 0.5 wt.% of CeO\(_2\) content. Hence 0.5–1 wt.% of CeO\(_2\) was chosen as optimum. Addition of MoO\(_3\) instead of La\(_2\)O\(_3\) to Ba\((\text{In}^{1/2}\text{Nb}^{1/2})\text{O}_3\) enhanced its densification and dielectric properties to a greater extent. By the addition of 0.5 wt.% MoO\(_3\) to the calcined Ba\((\text{In}^{1/2}\text{Nb}^{1/2})\text{O}_3\) powder, its density and dielectric constant were increased by 6%, normalized quality factor improved by 106% and there was no change in \( \tau_f \).

The X-ray diffraction patterns recorded from the powdered samples are in agreement with earlier reports (JCPDS files 24-1144, 24-1142, 24-1053, 24-1042, 24-1030, 37-858, 31-137, 37-857, 14-116, 37-856, and [14,15]). However, XRD patterns of some of the materials showed splitting of the main reflections indicating a non-cubic symmetry. Crystal symmetries of Ba\((\text{B}^{1/2}\text{Nb}^{1/2})\text{O}_3\) perovskites are slightly different from cubic due to the large difference in ionic radii between \( \text{B}^{1/2} \) and \( \text{Nb}^{1/2} \) ions. From the XRD pattern (Fig. 3), it is
clear that the amount of splitting of the main reflections increased with the decrease of tolerance factor. Galasso [14] reported the 
these compounds as face centered cubic with (NH₄)₂FeF₆ structure. But some of the earlier as well as recent studies [16–18,28,29] and ICDD files 37–856, 857, 858 have shown that the room temperature symmetry of these compounds may be different from cubic. 


These studies showed that the room temperature symmetry of A(OF₂)₂B(OH)₂O₃ can be cubic, tetragonal, orthorhombic or monoclinic depending on the tolerance factor (t) [16,17,26,27,30]. It was suggested that the difference in the crystal symmetry is due to the tilting of anion octahedra. A detailed description about the tilting of octahedra and their effect on the symmetry of perovskites was reported by Glazer [30,31]. It was shown [16–18] that compounds with t < 0.985 the symmetry is reduced from cubic due to antiphase or in-phase tilting of octahedra. Hence the splitting observed in some of our XRD patterns could be attributed to the lowering of symmetry. It is difficult to establish the correct symmetry and structure of these compounds from XRD because the scattering power of oxygen sub lattice is low and the tilt angle is being small [16–18,29]. Several authors [16–18,29] reported that complex perovskite compounds with non-cubic symmetry at room temperature are transformed to cubic at high temperature. Recently, these 


authors [16–18,29] reported that complex perovskite compounds with non-cubic symmetry at room temperature are transformed to cubic at high temperature. Recently, these compounds have been reported as cubic by Koshy et al. [20,32], as tetragonal by Zurnuhlen et al. [17], as monoclinic by Henni et al. [27] and as cubic by Brixner [33] except BaLa₃(OH)₂O₃ which is tetragonally distorted. In our XRD patterns an additional peak at 2θ ≈ 35° is observed in all the compounds with t < 0.985 whereas it is completely absent in the materials with t > 0.985 (see Fig. 3). Neutron diffraction and Raman spectroscopic studies are needed to determine precisely the structure and symmetry of these compounds. A detailed report on the structure and symmetry of Ba(Br₂)₂O₃ ceramics as studied using neutron diffraction, synchrotron radiation and spec-


trosopic methods is in progress and will be published elsewhere.


The microwave dielectric properties of Ba(Br₂)₂(OH)₂O₃ ceramics are given in Table 2. The different Ba(Br₂)₂(OH)₂O₃ compounds have high εᵣ which are in the range 36–45. The εᵣ of Ba(Br₂)₂(OH)₂O₃ ceramics was also calculated using the following Clausius–Mosotti equation are given in Table 2

\[
eᵣ = \frac{3V + 8\pi\alpha}{3V_m - 4\pi\alpha}
\]

where \(\alpha\) is the total dielectric polarizability and \(V_m\) is the molar volume. The observed dielectric polarizability was calculated by Clausius–Mosotti equation, given by

\[
\Delta \epsilon_{\text{observed}} = \frac{3V_m(\epsilon - 1)}{4\pi(\epsilon + 2)}
\]

and the theoretical dielectric polarizability by the total polarizabilities of constituent elements [34]. Theoretical dielectric polarizabilities show a shift from the observed ones. The variations in calculated εᵣ (using Eq. (3)) from the experimental εᵣ of Ba(Br₂)₂(OH)₂O₃ ceramics are due to this shift of \(\Delta \epsilon_{\text{observed}}\) from \(\Delta \epsilon_{\text{theoretical}}\).

The percentage shift of theoretical dielectric polarizability from the observed value is calculated by the following equation [35]

\[
\% \Delta \epsilon = \frac{\Delta \epsilon_{\text{observed}} - \Delta \epsilon_{\text{theoretical}}}{\Delta \epsilon_{\text{theoretical}}} \times 100\%
\]

Experimentally obtained εᵣ is greater than the calculated εᵣ since \(\Delta \epsilon_{\text{observed}}\) is greater than \(\Delta \epsilon_{\text{theoretical}}\). Since the correct symmetry of all the compounds are not known, the cell volumes are calculated using cubic perovskite cell parameter (aₒ) using Eq. (2). The actual unit cell symmetry may slightly deviates from cubic for each Ba(Br₂)₂(OH)₂O₃ ceramic. Qualitatively, the deviation is directly related to t.

Table 2

<table>
<thead>
<tr>
<th>8′ element</th>
<th>a (Å)</th>
<th>(\epsilon_0) (Å)</th>
<th>(%)</th>
<th>D (ppm/°C)</th>
<th>(\Delta \epsilon_{\text{observed}}) (%)</th>
<th>(\Delta \epsilon_{\text{theoretical}}) (%)</th>
<th>(\Delta \epsilon_{\text{calculated}})</th>
<th>(\Delta \epsilon_{\text{calculated}})</th>
<th>Q × f (GHz)</th>
<th>(\tau_i) (ppm/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>La</td>
<td>1.032</td>
<td>4.2061</td>
<td>97</td>
<td>0.98633</td>
<td>17.45</td>
<td>17.730</td>
<td>1.579</td>
<td>45</td>
<td>36.2</td>
<td>8.8</td>
</tr>
<tr>
<td>Pr</td>
<td>0.990</td>
<td>4.2751</td>
<td>97</td>
<td>0.9657</td>
<td>17.08</td>
<td>17.459</td>
<td>2.199</td>
<td>44.5</td>
<td>33.3</td>
<td>11.2</td>
</tr>
<tr>
<td>Nd</td>
<td>0.983</td>
<td>4.2716</td>
<td>98</td>
<td>0.96712</td>
<td>16.92</td>
<td>17.403</td>
<td>2.755</td>
<td>44</td>
<td>31.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Sm</td>
<td>0.958</td>
<td>4.2591</td>
<td>98</td>
<td>0.97272</td>
<td>16.79</td>
<td>17.224</td>
<td>2.549</td>
<td>43</td>
<td>31.2</td>
<td>11.8</td>
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<tr>
<td>Eu</td>
<td>0.947</td>
<td>4.2536</td>
<td>98</td>
<td>0.9752</td>
<td>16.68</td>
<td>17.070</td>
<td>1.406</td>
<td>40</td>
<td>33.6</td>
<td>6.4</td>
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<tr>
<td>Gd</td>
<td>0.938</td>
<td>4.2491</td>
<td>95</td>
<td>0.97725</td>
<td>16.60</td>
<td>17.015</td>
<td>2.459</td>
<td>40</td>
<td>30.0</td>
<td>10.1</td>
</tr>
<tr>
<td>Tb</td>
<td>0.923</td>
<td>4.2416</td>
<td>98</td>
<td>0.98067</td>
<td>16.54</td>
<td>16.894</td>
<td>2.095</td>
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<td>30.5</td>
<td>8.5</td>
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<tr>
<td>Dy</td>
<td>0.912</td>
<td>4.2361</td>
<td>96</td>
<td>0.98320</td>
<td>16.45</td>
<td>16.825</td>
<td>2.229</td>
<td>36.9</td>
<td>30.0</td>
<td>8.9</td>
</tr>
<tr>
<td>Ho</td>
<td>0.901</td>
<td>4.2306</td>
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<td>0.98733</td>
<td>16.40</td>
<td>16.746</td>
<td>2.066</td>
<td>38</td>
<td>30.2</td>
<td>7.8</td>
</tr>
<tr>
<td>Y</td>
<td>0.900</td>
<td>4.2301</td>
<td>96</td>
<td>0.98979</td>
<td>16.32</td>
<td>16.689</td>
<td>2.211</td>
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<td>29.0</td>
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</tr>
<tr>
<td>Yb</td>
<td>0.868</td>
<td>4.2141</td>
<td>97</td>
<td>0.99343</td>
<td>16.21</td>
<td>16.404</td>
<td>1.213</td>
<td>36</td>
<td>30.3</td>
<td>5.9</td>
</tr>
<tr>
<td>In⁺</td>
<td>0.800</td>
<td>4.1801</td>
<td>98</td>
<td>1.00067</td>
<td>15.73</td>
<td>16.069</td>
<td>2.140</td>
<td>36</td>
<td>28.5</td>
<td>7.5</td>
</tr>
<tr>
<td>In³⁺</td>
<td>0.8</td>
<td>4.1801</td>
<td>98</td>
<td>1.00067</td>
<td>15.73</td>
<td>16.189</td>
<td>2.746</td>
<td>39</td>
<td>28.5</td>
<td>10.5</td>
</tr>
</tbody>
</table>

Percent \(\Delta \) represents the percentage density, percent \(\epsilon\) represents the percentage shift in dielectric polarisability.

a Sintered with La₂O₃ additive.
b Sintered with MoO₃.
Fig. 4. Variation of dielectric constant, ionic polarizability, and bond valence with ionic radii of \(B^{3+}\) ions. Dotted lines separate the untilted (U), antiphase tilted (A), and inphase tilted (I) regions given by Reaney et al. \[18\]. In and Y are non lanthanides.

Fig. 4 shows the variation of \(\varepsilon_r\) of \(\text{Ba}(B^{1/2})\text{Nb}_{1/2}\text{O}_3\) ceramics with ionic radii of \(B^{3+}\) ions. The dielectric constant increases with the increase in ionic radius. The ionic polarizability of \(B^{3+}\) ions also increase with the increase in ionic radius. The variation of dielectric constant with tolerance factor \((t)\) is shown in Fig. 5, which is in agreement with that of Reaney et al. \[18\]. The small differences in \(t\) may be due to the fact that, Reaney et al. used the ionic radii given by Muller and Roy \[36\] to calculate the tolerance factor. In the present case we have calculated the tolerance factor using the ionic radii given by Shannon \[25\]. The inphase, antiphase, and untitled regions are marked in Figs. 4–7. Anti-phase tilting is within the tolerance factor range 0.967–0.987 (Fig. 5). Corresponding to this antiphase tilting the ionic radii range is 0.9–0.983 (Fig. 4). The \(\varepsilon_r\) of \(\text{Ba}(B^{1/2})\text{Nb}_{1/2}\text{O}_3\) ceramics decrease with increase in \(t\) as shown in Fig. 5. Since \(t\) is related to packing of ions in the perovskite cell, when \(t\) deviates from 1, the perovskite cell gets deformed and the symmetry is lowered from cubic. Any deviation from cubic symmetry results in extra polarization, which is reflected in the dielectric constant \[26\]. Thus, larger the deviation from the cubic symmetry, larger is the \(\varepsilon_r\) (see Table 2). The values of \(\varepsilon_r\) reported here are in good agreement with earlier reports on some of the compounds for which data is available, measured by direct microwave methods or spectroscopic methods \[15–17\], but very different from a recent report \[20\]. The \(\varepsilon_r\) of \(\text{Ba}(B^{1/2})\text{Nb}_{1/2}\text{O}_3\) ceramics increases with increase in dielectric polarizability (Table 2), in agreement with earlier reports \[35,37,38\].

The different \(\text{Ba}(B^{1/2})\text{Nb}_{1/2}\text{O}_3\) compounds have relatively high quality factor \((Q_f)\) up to 50,000 (see Table 2). The temperature coefficient of resonant frequency \((\tau_f)\) of \(\text{Ba}(B^{1/2})\text{Nb}_{1/2}\text{O}_3\) compositions are given in Table 2. The
Fig. 8. Percentage shift of dielectric polarisability and shift of dielectric constant of Ba(Br/2)Nb(2/2)O3 ceramics are plotted against the ionic radii of B’ ions.

Bar(Br/2)Nb(2/2)O3 ceramics have low τf values in the range from −22 to +17 ppm/°C. The values vary non-linearly with tolerance factor as shown in Fig. 5.

The bond valence was calculated from the bond parameters of Brown et al. [39]. Figs. 6 and 7 show the variation of αmax for Yb. The case of In. La2O3 and MoO3 are found to be good sintering aids for Ba(In1/2Nb(2/2))O3. The use of MoO3 as sintering aid increased the Q factor of Ba(In1/2Nb(2/2))O3 without affecting its τf. The Bar(Br/2)Nb(2/2)O3 ceramics show high εr in the range 36–45, high quality factor and low τf. The microwave dielectric properties are found to be related to the tolerance factor and octahedral tilts. The τf of Ba(Br/2)Nb(2/2)O3 ceramics increase with the dielectric polarizability, bond valence, bond length and ionic radii of the B’ ions. The τf of Bar(Br/2)Nb(2/2)O3 ceramics increase with the bond length and bond valence in the antiphase tilted region. The percentage shift of dielectric polarisability and the shift of obtained dielectric constant from their theoretical values indicate a lowering of symmetry of Ba(Br/2)Nb(2/2)O3 ceramics from cubic.

4. Conclusion

The Bar(Br/2)Nb(2/2)O3 [B’ = La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Y, Yb, and In] were prepared by conventional solid state ceramic route. The compounds based on In, Yb, Y, Ho, Dy, and Tb have poor sinterability. Addition of 0.5 wt.% of CeO2 as sintering aid improved their sinterability except in the case of In. La2O3 and MoO3 are found to be good sintering aids for Bar(In1/2Nb(2/2))O3. The use of MoO3 as sintering aid increased the Q factor of Bar(In1/2Nb(2/2))O3 without affecting its τf. The Bar(Br/2)Nb(2/2)O3 ceramics show high εr in the range 36–45, high quality factor and low τf. The microwave dielectric properties are found to be related to the tolerance factor and octahedral tilts. The τf of Bar(Br/2)Nb(2/2)O3 ceramics increase with the dielectric polarizability, bond valence, bond length and ionic radii of the B’ ions. The τf of Bar(Br/2)Nb(2/2)O3 ceramics increase with the bond length and bond valence in the antiphase tilted region. The percentage shift of dielectric polarisability and the shift of obtained dielectric constant from their theoretical values indicate a lowering of symmetry of Bar(Br/2)Nb(2/2)O3 ceramics from cubic.

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