Dear Reviewers:

I would like you to have a copy of the previous comments regarding the paper I am submitting. Since I have made a completely new version it is not possible for me to highlight the changes in color, however, all of the comments were carefully taken into account.

Please find attached a copy of the email I received along with small answers regarding the comment.

Best Regard

Jorge Yescas

Editor/Author Correspondence

Editor
2017-06-30 07:13 PM

DELETE

Subject: [AoM] 2674: Editor Decision
Dear Dr. Hernández,

We have reached a decision regarding your submission to Archives of Mechanics, AoM-2674 "Mechanical Characterization of mm Agarose Spheres Using a Resonant Technique".

The decision is: Revision Required.

The comments of the reviewers are attached.

In order to submit the revised version, taking into account the reviewers' comments, please log in to the journal web site using the link below:

Manuscript URL: http://am.ippt.pan.pl/am/author/submissionReview/2674
Username: jayescash

In the "Submit Revised Version" section, you can upload your revised manuscript and then notify the Editor by email. Please attach to the notification email the detailed response to the reviewers' comments along with the list of changes you have made in the revised version (preferably marked in color in the revised manuscript).

With kind regards,

Prof. Henryk Petryk
Editor of Archives of Mechanics
archmech-editor@ippt.pan.pl

Reviewer A:

Review:
The paper presents application of resonant spectroscopy for characterization of mechanical properties of agarose millimetric spheres. The authors present the paper as a proof of concept of application of resonant technique in kHz range for characterization of soft tissues. The article presents both experimental results obtained using low-cost experimental setup and theoretical analysis obtained by FEM simulation and analytical solution. The article is interesting, clearly written and can be accepted for publication in Archives of Mechanics.

Prior to the publication, some aspects can be considered in more details:
1) It is not clear from Tab. 1 how accurately were evaluated both constants Young's modulus and Poisson's ratio. The authors show that " for Poisson’s ratios 0.25, 0.3, 0.46, these ratios (R2/R3) are 1.48, 1.49 and 1.50" i.e. for large differences in Poisson's ratio the ratio between R2 and R3 is almost the same. Considering larger discrepancy between experimental and theoretical values of this ratio, it seems, that uncertainty in Poisson's ratio will be large.

A: A new section related with the ratio R3/R2 is added to explain this phenomenon (Section 5.6)

2) Considering the previous point, the most accurately determined constant is probably G instead of E. In the context of the article (development of a technique for characterization of soft tissues), it could be important to clearly declare, which elastic constant(s) can be determined with good accuracy (in my opinion G) and which cannot.
A: In the new version we propose to use the Octupole Frequency to estimate a value for the Young´s modulus (Section 5.7)

3) Is it possible to comment what is the origin of R1 peak?
A: Origin of R1 is due to Rigid Body motion and can be modelled using a lumped model (Section 5.8)
4) Typos: p. 4... \beta instead of b
p.4... 0.04ms
A: Changed

Reviewer B:

Review:
1. In the equations (2.1) and (2.2) the authors have not defined the variables: ξ and η (presumably normalized frequencies for spheroidal and torsional vibration modes)
A: These variables have been identified in the new version. Also, a glossary was included.

2. The node M2 mentioned in last paragraph of chapter 5 is not shown in Figure 2.
A: This node is no longer required.

3. In chapter 5 the authors made an assumption that the latex membrane of the sensor may not be taken into account when calculating the resonance frequencies of the experimental setup. Considering very low values of Young modulus of the agarose gel the validity of this submission is questionable. The reactive force exerted by the membrane on the vibrating sphere will strongly depend on the membrane tension and in some cases may affect the resonance behaviour of the experimental setup. The authors should more carefully analyse the problem of interaction between vibrating sphere and the latex membrane.
A: Membranes were properly stretched using the Bubble inflation test, their stiffness was accounted for through the system stiffness, and we found that (as the reviewer suggested) their stiffness has an impact on the resonances measured.

4. In chapter 6 the authors noticed that they consistently received experimental spectra with the highest resonant peak (R1) which did not show a clear dependence with neither sample size nor composition. In the following discussion they neglect that peak without giving any explanation of its nature and origin. It may suggest that the authors do not fully understand the resonant behaviour of their experimental setup. So, it is recommended that the authors carefully analyse the nature of this dominant resonance peak and explain it in the updated text.

A: Origin of R1 is due to Rigid Body motion and can be modelled using a lumped model (Section 5.8). In the previous version we could not detect the dependence since we did not have control of force used to press the sample between the PZT platform and sensor. In the new experimental setup a force sensor was added and by doing this we were able to detect the dependence the reviewer mentions in his comment.

5. In Figure 5 the simulated amplitude spectra of the vertical displacement at nodes M1 and M2 (in response to an impulse excitation) are shown and interpreted as the lowest Quadrupole and Octupole spheroidal modes. Unfortunately the authors present no evidence of such an interpretation. In the mentioned ABAQUS simulations it should be possible to calculate and visualize the actual shapes of vibration modes corresponding to the 2.4 kHz and 3.7 kHz resonance peaks. Such pictures could confirm their interpretation and exclude the possibility that the peaks represent other spheroidal modes (for example Dipole mode (2S1) or Breathing mode (1S0)).

A: Images for the Quadrupole and Octupole modes of vibration were included in the new version (See Table 3).

6. In the formula (7.1) the normalized frequencies of Quadrupole (Qp) and Octupole (Op) lowest modes are approximated be the linear dependence on the Poisson's ratio.
A reference to the source of this relationships should be given.
A: The idea of fitting this modes comes form the authors and we have included an image to show this behavior (See Figure 1).

7. In chapter 7 the authors noticed that samples of similar size and agarose concentration doesn't give similar E values as may be expected. For example, the Young modulus difference between sample S16 (140 kPa) and S17 (300 kPa) exceeds 100%. The authors offer somewhat doubtful explanation to this fact that the cause is the presence of small bubbles inside the spheres. The porosity that cause such a big effect would have to be rather large and should be clearly noticed at the sample preparation stage. Anyway, the authors should take care for the consistent preparation of the samples used for evaluation of the new methodology.

A: Discrepancy in the Young´s modulus values was reduced by assuming a Poisson´s ratio near 0.5 and by taking into consideration the system stiffness. Additionally, a device to prevent bubbles formation during their manufacturing (Section 4.1).

8. The measurement results presented in the Table 1 show Poisson's ratios ranging from 0.25 to 0.40. These are very unusual values for gel like materials which normally exhibit Poisson's ratio approaching 0.5. The authors should carefully explain this peculiarity as it causes serious doubts about integrity of their measurements.

A: Authors agree with the Reviewer

9. The authors conclusion in chapter 8 that the methodology proposed in their paper was successfully proved on millimetric spheres made of agarose is somewhat exaggerated. The dispersion of elastic properties measured on samples made of nominally the same material is too big and the determined values of the Poisson's ratio are doubtful.

A: New results are narrower and agree well with theoretical and numerical calculations.

10. The proposed technique is interesting and potentially promising but needs further research and rectification, especially concerning the explanation of all resonances detected in the testing system. The important weakness of the presented work is also the

small number of samples used for verification of testing methodology.
Two samples made of 2% agarose and three samples made of 4% agarose are definitely too small numbers to draw sound conclusions about the technique reliability and accuracy.
A: A greater number of samples of different composition has been tested

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