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Large deformation contact of a soft material with a rigid indenter by digital moirAC method

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Summary

Soft materials are a special class of materials between the ideal fluid and solid (Gennes, 1992), comprising a variety of physical states that are easily deformed by mechanical loading or thermal fluctuations. They are increasingly important in a wide range of technological applications, and the related contact problem is rather complex due to geometrical and material nonlinearities and complicated boundary conditions. Measuring, characterizing, and modeling the contact behavior of soft materials is still a challenging topic for engineering researchers. In this work, through combination of digital moirAC method and inner-grating approach an experimental technique has been developed for measuring and analyzing contact behaviour of soft materials undergoing large deformation. The technique is applied to investigate a vulcanized silicone rubber being contacted with a wedge-shaped indenter. By analyzing the raw information with digital image processing method, it is found that there exist two deformation sectors, namely, a so-called shrinkage sector (SS) symmetric to the loading axis and an expansion sector (ES), which agrees qualitatively with the prediction by Gao and Mai (2002). Further, the strain distribution near the contact area is also presented using the results of grid deformation and within the framework of finite deformation elasticity theory. In the analysis, the solution domain is divided into three regions along the horizontal direction: the contact region, the sink-in region and the far-field region. At the end of the paper, a constitutive model suitable for the specimen is determined by experiments, and the distribution of contact pressure and shear stress over the contact interface are presented.