PATENT CLAIMS

1. Contact force testing apparatus (10) comprising a measuring sensor (100), which measuring sensor (100) can be contacted with an electrical contact element (1, 2) and measures a contact force (F) of a contact with the electrical contact element (1, 2), wherein the measuring sensor (100) comprises piezoelectric material (102, 103) which receives the contact force (F) in a contact region (3) and produces polarization charges, and wherein the measuring sensor (100) comprises an acceptor electrode (104) which is completely surrounded by piezoelectric material (102, 103) in the contact region (3) in the direction of a thickness extension of the measuring sensor (100) and receives the polarization charges, characterized in that the measuring sensor (100) comprises a base plate (101), which base plate (101) is disposed in the direction of an elongate extension of the measuring sensor (100), which elongate extension runs parallel to a central axis (XX') of the measuring sensor (100); that a first layer of piezoelectric material (102) is connected to the base plate (101) in the contact region (3) via a side facing the central axis (XX'); that the acceptor electrode (104) is connected to the first layer of piezoelectric material (102) in the contact region 3 via a side facing the central axis (XX'); and that a second layer of piezoelectric material (103) is connected to the acceptor electrode (104) in the contact region (3) via a side facing the central axis (XX').

2. The contact force testing apparatus (10) according to claim 1, characterized in that the layer of metallic material consists of first metallizations of the two adjacent layers of piezoelectric material (102, 103), which first metallizations are connected to one another in a firmly bonded manner.

3. The contact force testing apparatus (10) according to claim 2, characterized in that the thickness of the first metallizations is greater than/equal to the maximum roughness of the piezoelectric material (102, 103).

4. The contact force testing apparatus (10) according to claim 2 or claim 3, characterized in that a first layer of piezoelectric material (102) in the direction of an elongate extension of the measuring sensor (100) is configured to be longer than a second layer of a piezoelectric material (103); that in the region where the first layer of piezoelectric material (102) is configured to be longer, the first metallization of the first layer of piezoelectric material (102) is connected in a firmly bonded manner and/or non-positively to an electrical conductor (109, 109').

5. The contact force testing apparatus (10) according to any one of claims 1 to 4, characterized in that a base plate (101) of the measuring sensor (100) is connected in a firmly bonded manner to a first layer of piezoelectric material (102); and/or that a base plate (101) of the measuring sensor (100) is provided on one side with a second metallization, which base plate (101) is connected via the second metallization in a firmly bonded manner to a first layer of piezoelectric material (102).

6. The contact force testing apparatus (10) according to claim 5, characterized in that a cover plate (105) of the measuring sensor (100) is connected in a firmly bonded manner to a second layer of piezoelectric material (103); and/or that a cover plate (105) of the measuring sensor (100) is provided on one side with a third metallization, which cover plate (105) is connected via the third metallization in a firmly bonded manner to a second layer of piezoelectric material (103).

7. The contact force testing apparatus (10) according to claim 6, characterized in that the measuring sensor (100) comprises a plurality of piezoelectric pick-ups (11, 11'); that each piezoelectric pick-up (11, 11') comprises a first layer of piezoelectric material (102) with the second metallization, the acceptor electrode (104) and a cover plate (105) with the third metallization; and that the piezoelectric pick-ups (11, 11') are arranged rotationally offset with respect to one another by a central axis (XX') of the measuring sensor (100).

8. The contact force testing apparatus (10) according to claim 7, characterized in that the contact force (F) of an electrical contact element (2) contacted in the contact region (3) by the contact force testing apparatus (10) acts obliquely to the longitudinal extension of the measuring sensor (100); that the measuring sensor (100) can be contacted with the electrical contact element (2), the electrical contact element (2) is a contact socket with contact socket lamellae (21, 21'); and that the piezoelectric pick-ups (11, 11') lie underneath the contact socket lamellae (21, 21') with respect to the central axis (XX') of the measuring sensor (100).

9. The contact force testing apparatus (10) according to claim 8, characterized in that after the contact of the measuring sensor (100) with the electrical contact element (2) precisely one piezoelectric pick-up (11, 11') of the measuring sensor (100) lies underneath precisely one contact socket lamella (21, 21'); and that each piezoelectric pick-up (11, 11') measures the contact force (F) of a contact socket lamella (21, 21').

10. The contact force testing apparatus (10) according to claim 8, characterized in that after the contact of the measuring sensor (100) with the electrical contact element (2) all the piezoelectric pick-ups (11, 11’) measure the contact force (F) of all the contact socket lamellae (21, 21’).

11. The contact force testing apparatus (10) according to any one of claims 1 to 10, characterized in that the measuring sensor (100) comprises a plurality of piezoelectric pick-ups (11, 11’); that the piezoelectric pick-ups (11, 11’) are spaced apart from one another by pick-up gaps (12, 12’); that the measuring sensor (100) has a protective sleeve (107); and that the protective sleeve (107) covers the piezoelectric pick-ups (11, 11’) and the pick-up gaps (12, 12’) in the contact region (3).

12. The contact force testing apparatus (10) according to claim 11, characterized in that the protective sleeve (107) abuts non-positively against the piezoelectric pick-ups (11, 11’) in the contact region (3).

13. The contact force testing apparatus (10) according to any one of claims 1 to 12, characterized in that the measuring sensor (100) is only electrically insulated by the piezoelectric material (102, 103) in the contact region (3).

14. Use of a contact force testing apparatus (10) according to any one of claims 1 to 13, characterized in that the piezoelectric material (102, 103) consists of piezoelectric crystal; and that the contact force testing apparatus (10) can be used at operating temperatures greater than/equal to 100°C, preferably at operating temperatures in the range of 140°C to 160°C, preferably at operating temperature less than/equal to 600°C.

15. Method for producing a contact force testing apparatus (10) according to any one of claims 1 to 14, characterized in that two layers of piezoelectric material (102, 103) are prepared, which layers of piezoelectric material (102, 103) are metallized on one side with first metallizations; and that the two layers of piezoelectric material (102, 103) are connected to one another in a firmly bonded manner via their first metallizations; or that the first metallizations of the layers of piezoelectric material (102, 103) are connected to one another in a firmly bonded manner by diffusion welding at metallization temperatures between 100°C and 450°C.