Patent Claims

1. A MEMS sound transducer to generate and/or detect sound waves in the audible wavelength spectrum with
a carrier substrate (2),
a cavity (3) executed in the carrier substrate (2), which has at least one opening (4), and
a multilayered piezoelectric membrane structure (5),
spanning over the opening (4) of the cavity (3) and connected in its edge area with the carrier substrate (2), so that with respect to the carrier substrate (2), it is capable of vibrating to generate and/or detect sound energy,
wherein the membrane structure (5) has in cross-section at least in some areas a first and a second piezo layer (8, 9) arranged separately from it,
characterized in that
an interlayer (19) is arranged in the area between the two piezo layers (8, 9),
~~that is executed~~ so that by means of it, sound energy can be reflected in the direction of at least one interface (17, 18) of the membrane structure (5) adjacent to the air.

2. A MEMS sound transducer according to the previous claim, characterized in that the interlayer (19) has lower density compared to at least one of the two piezo layers (8, 9).

~~3. A MEMS sound transducer according to one or several of the previous claims, characterized in that the interlayer (19) is made of silicon oxide, silicon nitride and/or polysilicon.~~

~~4.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that at least one of the two piezo layers (8, 9) is made of lead-zirconate-titanate and/or aluminum nitride.

~~5.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the two piezo layers (8, 9) are in each case embedded between a lower and an upper electrode layer (10, 12; 11, 13),
that the interlayer (19) sits tightly directly on the upper electrode layer (11) of the first piezo layer (8) and on the lower electrode layer (9) of the second piezo layer (12) and/or that the interlayer (19) is dielectrically executed.

~~6.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the membrane structure (5) has a membrane layer (14), particularly of polysilicon, preferably arranged below the first piezo layer (8) or in the area above the second piezo layer (9).

~~7.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the membrane structure (5) has, particularly in the interior of the carrier substance (2) executed as frame and/or on its side facing away from the carrier substrate (2), at least one recess (24) in whose area at least the two piezo layers (8, 9) have been removed, so that when seen from the top, the membrane structure (5) has at least one piezoelectrically active area (25) and at least one passive area (26) created by the recess (24) that preferably form a pattern (28) to one another.

~~8.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the recess (24) has been executed in such a way that the piezoelectrically active area (25) has at least one anchoring end (29, 30) attached to the frame in the top view and has at least a free end (31) that can vibrate in a z-direction with respect to it.

~~9.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the active area (25) has in the top view at least one, especially beam-shaped, deflection section (32, 33, 34) and/or
that in its sectional view, in at least one of its two piezo layers (8, 9), at least one of the two electrode layers (10, 11, 12, 13) is asymmetrically arranged with respect to the corresponding piezo layer (8, 9).

~~10.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the active area (25) in the top view has at least one first deflection section (32), a second redirecting section (33) and/or a deflection section (35) executed between these two.

~~11.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the membrane structure (5) in the top view has several transducer areas (38, 39) especially separately controllable from one another that are preferably executed in different sizes and/or have different patterns (28).

~~12.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the carrier substrate (2) has in the top view at least one supporting element (40) executed in the interior of the

frame, preferably arranged to support the membrane structure (5) between two transducer areas (38, 39).

~~13.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the supporting element (40) is attached to the membrane structure (5) with its supporting element end (43) that faces the membrane structure (5), sits loosely on it or is separated from it in the z-direction.

~~14.~~ A MEMS sound transducer according to one or several of the previous claims, characterized in that the supporting element (40) is executed as wall and partitions the cavity (3) into at least two cavity areas (41, 42).

~~15.~~ A chip, especially silicon chip, to generate and/or detect sound waves in the audible wavelength spectrum with several MEMS sound transducers (1) arranged in array-like fashion to one another and/or separately controllable from one another, characterized in that at least one of the MEMS sound transducers (1) is executed according to one or several of the previous claims.

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a cavity (3) executed in the carrier substrate (2), which has at least one opening (4), and
a multilayered piezoelectric membrane structure (5),
spanning over the opening (4) of the cavity (3) and connected in its edge area with the carrier substrate (2), so that with respect to the carrier substrate (2), it is capable of vibrating to generate and/or detect sound energy,
wherein the membrane structure (5) has in cross-section at least in some areas a first and a second piezo layer (8, 9) arranged separately from it,
characterized in that
an interlayer (19) is arranged in the area between the two piezo layers (8, 9),
that is made of silicon oxide, silicon nitride and/or polysilicon,
so that by means of it, sound energy can be reflected in the direction of at least one interface (17, 18) of the membrane structure (5) adjacent to the air.

2. A MEMS sound transducer according to the previous claim, characterized in that the interlayer (19) has lower density compared to at least one of the two piezo layers (8, 9).

3. A MEMS sound transducer according to one or several of the previous claims, characterized in that at least one of the two piezo layers (8, 9) is made of lead-zirconate-titanate and/or aluminum nitride.

4. A MEMS sound transducer according to one or several of the previous claims, characterized in that the two piezo layers (8, 9) are in each case embedded between a lower and an upper electrode layer (10, 12; 11, 13),
that the interlayer (19) sits tightly directly on the upper electrode layer (11) of the first piezo layer (8) and on the lower electrode layer (9) of the second piezo layer (12) and/or that the interlayer (19) is dielectrically executed.

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that in its sectional view, in at least one of its two piezo layers (8, 9), at least one of the two electrode layers (10, 11, 12, 13) is asymmetrically arranged with respect to the corresponding piezo layer (8, 9).

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frame, preferably arranged to support the membrane structure (5) between two transducer areas (38, 39).

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13. A MEMS sound transducer according to one or several of the previous claims, characterized in that the supporting element (40) is executed as wall and partitions the cavity (3) into at least two cavity areas (41, 42).

14. A chip, especially silicon chip, to generate and/or detect sound waves in the audible wavelength spectrum with several MEMS sound transducers (1) arranged in array-like fashion to one another and/or separately controllable from one another, characterized in that at least one of the MEMS sound transducers (1) is executed according to one or several of the previous claims.