SILVER, GOLD, PLATINUM - AND THE SOUND OF THE FLUTE

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Abstract

The discussion on the influence of the material of wind instruments on the sound color is unending. While acousticians speak mostly of a negligible influence, players are convinced that the material highly influences the color of the radiated sound. This paper reports on experiments done with 7 different flute materials and 110 testpersons, where the price of the instruments is between US $1,000 and $70,000. Double blind tests and statistical analysis showed players‘ and listeners´stereotyped ideas on that matter and the non-recognizability of the used material. Sound analysis pointed out big differences in the sound level and sound color of played tones caused by the player and just measurable but not perceivable differences (< 0,5 dB) in sound color caused by the material. Sound examples are given and the audience is invited to judge for themselves.

INTRODUCTION

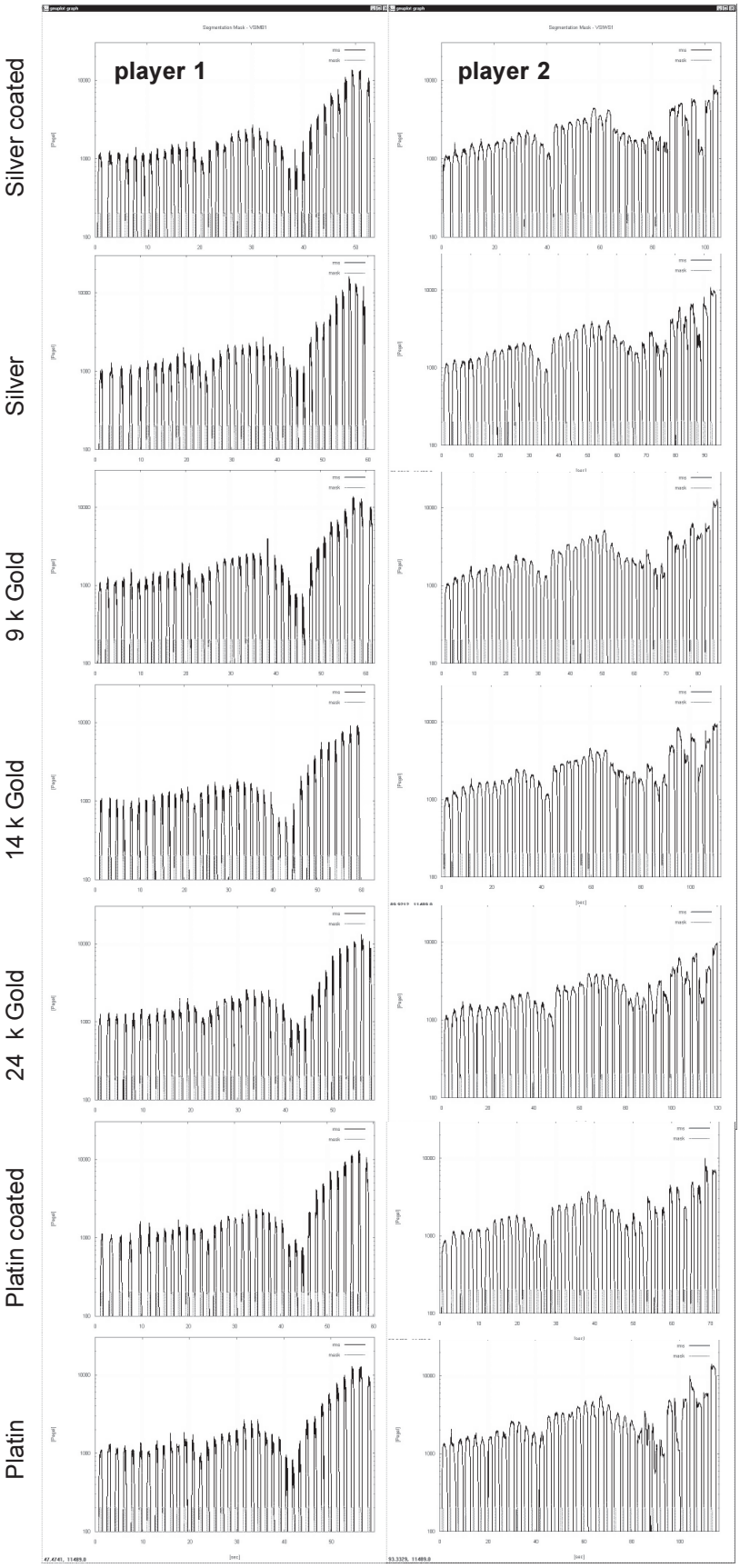
The role that the wall material plays in determining the tone quality of flutes has long been a subject of argument. Laboratory measurements of sustained tones in artificially blown wind instruments made by J. Backus in the 1960's [1,2] generally showed no evidence that the wall material has an appreciable effect. But players and instrument makers didn't accept these results because of the fact that the instruments were artificially blown. Therefor J. W. Coltman worked out an experiment with flutes made of three different materials (silver, copper and wood) and with different wall thickness. They were blown by the author himself and four different professional flutists [3]. The experiment was completed by listening test with 27 observers. The result of statistical analysis was that "no evidence has been found that experienced listeners or trained players can distinguish between flutes . . . whose only difference is the nature and thickness of the wall material of the body, even when the variations in the material and thickness are very marked." Nevertheless instrument makers, players and listeners continue to insist that the nature of the wall material does indeed have an effect on the instruments'sound. Perhaps, from the point of view of flutists, there is a stigma attached to J. Coltmans´ experiment: the flutes where built especially for this experiment and without any keywork.
To terminate this discussion once and for all (which, as J. Backus pointed out [4], probably started in early Stone Age circles with assertions that a flute made from a human thigh bone had a much better tone than one made from a stick of bamboo), we chose seven identical flutes made by Muramatsu which only differ in the wall material and could be purchased by everybody.

EXPERIMANTAL SETUP

A silver coated, full silver, 9 karat gold, 14 karat gold, 24 karat gold, platinum coated and all-platinum flute was played by 7 professional flutists (members of Viennese orchestras including the Vienna Philharmonic orchestra) in an anechoic chamber. The recorded sound material: a chromatic scale over 3 octaves (c4-c7) instruction: convenient *forte*, a *crescendo* up to *fff* and a *decrescendo* up to *ppp* on the single notes a^4, f^5, d^6 and bb^6, the famous solo from Carmen (Bizet) and the solo of the 1st Symphony of J. Brahms.
The sound material was analyzed and prepared for a listening test with 15 experienced professional flute players including the seven test players. An additional opinion survey was done on the question of the influence of the material on the sound, response and if there is any relationship between the wall material and the soundcolor of a flute with 111 persons.

RESULTS

A good estimation of the influence of the player and the material on the radiated sound gives an RMS of the played chromatic scale. Figure 1 gives an example of two players with the seven test instruments.



Differences are rather seen between the players whilst those between the instruments are extremely small. This implies that flute players can realise their subjective imagination of "a good sounding" to a far extent independently of the instrument.

Dynamic

A common stereotype is that Platinum flutes provide the the player with a larger dynamic range.

Figure 2 on the next page shows the mean value of all players and four notes of the low, middle and high register for each instrument. The difference of the instrument with the smallest dynamic range (14 karat gold flute = 14.57 dB) and that with the largest range (platinum flute = 16.14 dB) is only 1.5 dB! The possibility that this difference becomes zero with an increased number of test players can not be excluded.

Quite different is the situation if one looks at the individual dynamic range of the players (Figure 3 next page). The obtained dynamic range is between 7 dB and 19.6 dB. The figure shows the mean values for each player, all instruments and the notes a^4, f^5, d^6 and bb^6. The highest obtained dynamic is four times as much as the lowest.

As the Dynamic range is a "relative" value, the table on the next page gives information on the obtained absolute values for each note.

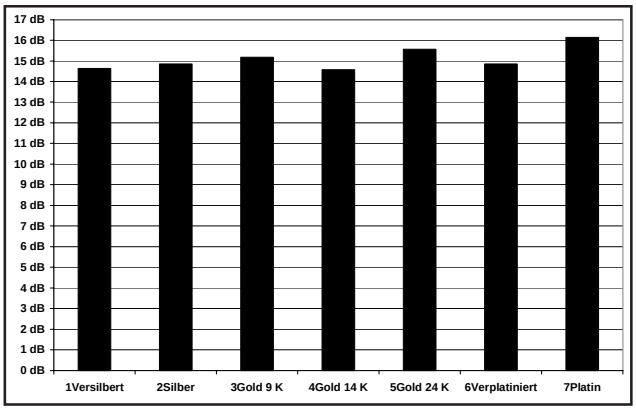


Figure 2: Mean value of the dynamic range for each instrument (7 players, 4 notes)

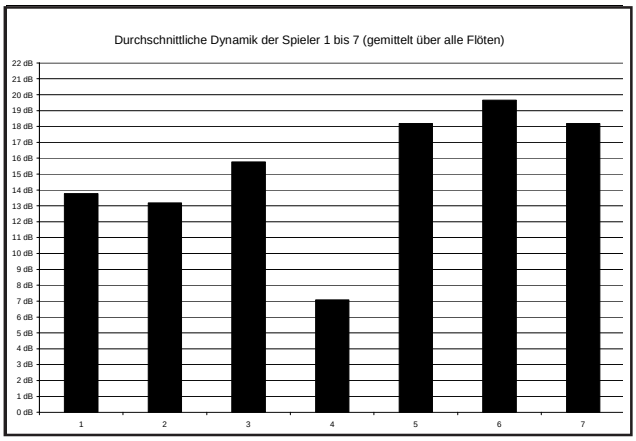


Figure 3: Mean value of the dynamic range obtained by the player (7 flutes, 4 notes)

	pp	*ff*
a^4	69-80 dB	82-92 dB
f^5	66-83 dB	81-96 dB
d^6	72-86 dB	88-100 dB
bb^6	72-95 dB	85-107 dB

Obtained absolute values for each note by 7 players.

Sound Color

Similar is the situation for the sound color. The sound spectrum differs extremely between the various players. But analyzing the sound spectra of the notes played by one player with different instruments, only just measurable but not recognizeable differences can be found. This fact was demonstrated strikingly by the listening tests.

Figure 4 (below) points out that the largest difference in sound caused by the material over the entire frequenc range of 0-16 kHz is less than 0.5 dB! The figure shows 7 lines (one line for each instrument). Each line represents the smoothed envelope (cepstrum with 36 coefficients) of the sound spectrum obtained from all players with one instrument. In this way, the influence of the individual player is eliminated.

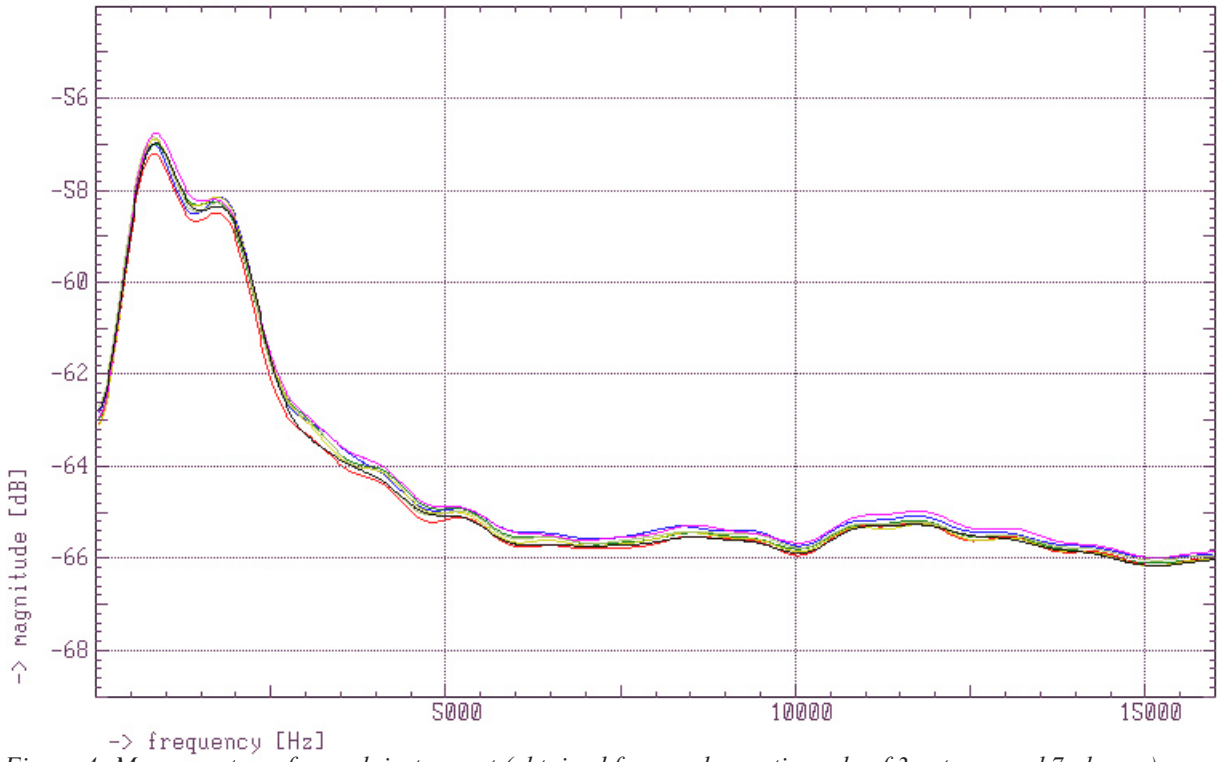


Figure 4: Mean spectrum for each instrument (obtained from a chromatic scale of 3 octaves and 7 players)

Listening tests

There were two tests made: in **TEST A,** the Carmen solo and the Brahms solo was presented (from a CD), at first from Player 1 with all instruments, then Player 2 with all instruments and so on. The test persons had to guess the instrument. The result was interesting: no instrument was identified correctly. The best value was that for the 24 k Gold flute: only 22% of the test persons identified it as a 24 k Gold flute. Whereas the wrong allocations had much higher values: 34% identified the Platinum flute as a 9 k Gold flute (only 6.8% identified it correctly) and 32% thought that the 14 k Gold flute is the Platinum flute (11.3% were right)!

With **TEST B,** we tried another approach: the test persons listened to one instrument played by all players. They had to describe the sound color and to guess the instrument/material. Then the next instrument played by all players was presented, and so on. Only one instrument (the all-silver flute) was identified correctly, with all other instruments the confusion was perfect! For instance: the 9 k gold flute was mainly misinterpreted as an all-silver instrument, the 14 k gold flute was identified as the platinum instrument and the silver coated instrument was assigned to all instruments (with each instrument at least one test person thought that it is the silver-coated instrument).

The descriptions of the soundcolor for each instrument were separated into 5 categories:

positive occupied expressions
negative occupied expressions
from all persons assigned expressions
contradictionary expressions
evaluation of the sound quality (1= very good, 5 = bad)

As expected, the most significant assigned expressions for all instruments were the "contradictionary expressions": for example, the sound color of each instrument was evaluated as "bright" and simultaneously as "dark" or "full/round" and "thin/sharp".

The evaluation of the sound quality showed a very small range: the values for all instruments can be found between 2.16 and 2.92. In addition to the evaluation of the sound quality, the test persons were free to use a "+" for "I like it" and a "-" for "I don't like it". The following table points out the listeners' preference depending on the played music.

Instrument	Sound Quality (mean value)	Brahms	Carmen
9 k Gold	2.16	++++	+++++ -
24 k Gold	2.38	+++ - -	+++ - - - -
Platinum	2.60	+ - - - -	++++ - - -
Silver coated	2.66	+++++ - -	+++++ - - - -
Platinum coated	2.79	+++ -	++ - -
14 k Gold	2.79	+++ - - -	++
All Silver	2.92	+ - -	++ - - - -

CONCLUSION

Tests with experienced professional flutists and listeners and one model of a flute made by Muramatsu from 7 different materials showed no evidence that the wall material has any appreciable effect on the sound color or dynamic range of the instrument. The common stereotypes used by flutists and flute makers are exposed as "stereotypes".

[1] J. Backus, JASA Vol.36, p. 1881-1887, (1964)
[2] J. Backus, T.C. Hundley, JASA Vol.39, p. 936-945, (1966)
[3] J. W. Coltman, JASA Vol.49, p. 520-523, (1971)
[4] J. Backus, *The Acoustical Foundations of Music*, p. 208, Norton, New York (1969)