

## Preamble

The original article in Chinese is published at AV Front Line, the largest Chinese Hifi journal in circulation. The author living in Philadelphia at the time of writing is a 30-year old college professor who started teaching business course in mid-20s with a load of flexible (not free) time on hand. One of the many hobbies he has is to listen to classic music live or at home. He is also a dedicated mint vintage tube Hifi collector and restorer. Occasionally he finds time to publish articles in Chinese magazines and newspapers, with all proceeds donated to education charities.

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**The World's Best Capacitors**  
**A shoot-out of 21 popular hi-end capacitors**  
December 2005

A little indispensable device in hi-fidelity equipment is called a capacitor. It stores energy in the electric field created between a pair of conductors on which equal but opposite electric charges have been placed. Capacitors have thin conducting plates (usually made of metal), separated by a layer of dielectric, then stacked or rolled to form a compact device. Conducting plates can be aluminum, tin, copper, silver or alloys. Dielectric materials can be just about anything that is non-conductive, e.g. air-gap, glass, ceramic, mica, paper, mylar, polystyrene, polypropylene, and Teflon®.

One of many applications for capacitors is signal coupling – blocking DC while allowing musical signals (AC) to pass. Since there is no such thing as a “perfect” capacitor, any capacitor in the way of signal path has the potential to degrade the signal to various degrees. This is a big no-no in hi-fidelity equipment. The logical solution is direct-coupling that excludes the use of capacitors. However, anyone with basic understanding of electronic circuits knows the actual implementation of direct-coupling is not only difficult, but also severely limited in its applications.<sup>1</sup> Therefore, we are striving to find the best coupling capacitors that do least harm. This is the very focus of this review that took 14 months to finish and involves 21 high-end capacitors.

### **Overview of the Capacitors under the Review**

Table 1 provides the list of capacitors, along with descriptive statistics such as retail price. The capacitors are from all over the world with American and European brands dominating the list. China and the former Soviet Union each has one representative. According to this author's knowledge, some American and European branded caps are actually manufactured China. This trend may continue and expand in the future.

The dielectrics used among the 21 caps are paper-in-oil, polys, beeswax and paper, oil, Teflon® or combinations of them. Conducting materials include tin, aluminum, copper, silver, and silver gold alloy. A few manufacturers did not disclose the metal or alloy used in their caps. Construction types are either film and foil rolled together, or metallized dielectric with deposited conducting materials. While traditionally film and foil is superior in sound while also being more expensive, more economical modern metallized dielectric designs are catching up rapidly.

All capacitors are readily available in the U.S. through dealers or online. I included all manufacturers' English websites for readers who are interested in additional information or to purchase.<sup>2</sup> The prices listed in Table 1 are MSRP in the North America as of October 2005. In a few cases where MSRP is not available, the actual purchase price is substituted.

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<sup>1</sup> Since direct-coupling is more or less the holy grail of hi-fi design, it is falsely advised by unscrupulous manufacturers from time to time. One example is the \$350,000 WAVAC SH-833: while the manufacturer claims there is no capacitors used in the audio circuit, John Atkinson, the Editor of *Stereophile*, “*counted four in the amplifier chassis, two of which do appear to be in the audio circuit.*”

<sup>2</sup> Xicon does not have an English website. Therefore their US distributor's website is listed instead.

## **Potential Limitations of the Review**

As with any scientific experiment, the results of the review are limited by the design and setting.

First, any conclusion on the capacitors is strictly limited in the signal coupling in the high-end electronics. You should not extend the implication of the same capacitor into speaker crossover, power supply, tuned circuit, and high frequency filter. For example, in tuned circuit in high-end tuners, the most important parameter of capacitors is temperature stability to prevent drift. Hence silvered mica or ceramic caps are ideal for this application, albeit their sound is notorious for signal coupling.

Second, while I tried to cover as many high-end capacitors as I can, it is impossible to cover them all. Therefore, please don't take offense if your favorite cap is not on the list. Alternatively, some of you may consider economically priced caps like Solen or Xicon are not true high-end. The author feels these caps are so widely used in hi-end manufacturing or vintage equipment restoration that they DO warrant their place here.

Third, in the spirit of full disclosure, the review samples are mostly purchased on the open market in the U.S. or Europe, with exceptions of V-cap being purchased with industry accommodation discount directly from the manufacturer, since there is no alternatively means of procurement, and Mundorf caps given by a manufacturer's friend who uses the brand extensively. Purchasing review samples from the open market precludes potential "spiking" by manufacturers, and provides the author with an unbiased review process without any obligation to manufacturers. This is also how automobile industry reviews work. Unfortunately, hi-end audio magazines are not financially endowed to conduct business this way. The author is lucky enough to be able to do this only in this article due to the financial support of a well-heeled audiophile who is also in pursuing the ultimate signal coupling capacitor.

Fourth, any subjective judgement of sound characteristics is from the standpoint of author's taste and hearing along with the system synergy. Your mileage may vary. Therefore it is imperative for me to brief the evaluation platform, the whole equipment system, and my listening repertoire.

## **Evaluation Setting and Methodology**

All capacitors are evaluated at output coupling position in a copy of Audio Note M7 preamp by this author according to the published schematics. To protect the privacy of the friend who provides the platform, audio system, and financial support for capacitor procurement, I cannot give detailed layout of the whole system. However, I can assure you the audio system is easily the top three best I've ever heard, and costs almost a quarter of million dollars at retail pricing. Essentially, the preamp replaced a factory wired Audio Note M10 to drive the original "top of the line" Audio Note monoblocks that cost over \$100k and is an incredible horn speaker setup. I consider this ultra high-resolution, ultra-highend system to be an ideal platform for bringing out the best and the worst of each capacitor.

My listening repertoire is 60% large-scale orchestral pieces, 30% "light-weight" classical music such as violin concerto, and 10% classical jazz. Evaluation is done

through an LP library that is loaded with Classic Records 45 reissues, RCA Living Stereo (many first pressings), Mercury Living Presence, and a large assembly of operatic London pressings.

Since there is no perfect sounding gear in existence, the author rates the sound with emphasis in dynamics, tonality, details, soundstage, and then other usual criteria.

All capacitors are 0.1uf/600VDC. If 600V is not available, the closest rated one was chosen. All capacitors are “broken-in” at least 500 hours using “white noise”: the RCA outs from tuners tuned between stations. Then the capacitors were installed into the Audio Note M7 for evaluation.

Now the main course of the article.

### **Capacitor Rankings**

We report the ranking of the capacitors by groups. The lowest ranking was reported first. The ranking is solely based on the sound, not price/performance ratio. You should not dismiss a capacitor simply because it is in Class D. For most people, a majority of Class D caps are better than any caps currently in their audio gear. Class C is reserved for a very select few. Class B is excellent, but unfortunately so expensive that few manufacturers will ever use the caps. We only have two capacitors in Class A, and I guarantee they are a head-and-shoulder above Class B and rest of the caps. In the end, this is an exceptional group of capacitors that includes the world’s best!

#### *No Class*

To be good enough to have any class ratings, the cap must have no significant shortcomings. This group consists of Solens, Xicon, and Jupiter- which all have unforgivable drawbacks in a high-end system.

#### Xicon

This is the cheapest capacitor in the group. The construction is metallized polypropylene. Further technical details are sketchy since it is made in China and the factory does not have an English website.

Sound-wise, it is dynamic and fairly neutral. Its Achilles’ heel is that it is bright sounding. In Asian terms, this would be called sounds “too fast”.<sup>3</sup> I have been wondering why nowadays Xicon caps are so popular in vintage gear restoration. Its characteristics are just the ticket to fix some dark, slow sounding vintage gear. Furthermore, average vintage restorers are comparatively frugal with their wallet when replacing components. This, along with the fact that vintage gear typically requires a great deal of capacitor replacement, makes Xicon a first choice in vintage restoration.

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<sup>3</sup> Definitely not to be confused with the American word “fast” that meaning dynamic.

## Solen/PPE and Solen/SM

Among hi-end manufacturers, Solen is indisputably the most widely used capacitor brand. It is difficult to open hi-fi gear without finding Solen inside. The two Solens under review, while different in construction, were found to have similar sound.

According to the manufacturer, these caps have “Superior high frequency characteristics; Dissipation factor: Less than .01 %; Dielectric absorption factor: Less than .01%; Insulation resistance: More than 100 K megohms/mfd; Dielectric: Polypropylene Film”.

The Solen Châteauroux Fast caps are a step-up from Xicon capacitors, but have disappointing resolution and slow sound, however. There is no other vital shortcoming although neither excel in any area. With low price, particularly with manufacturer’s quantity pricing, it’s no wonder this is a ubiquitous cap. The sound overall is closed-in with a slightly prominent midrange, and is a bit congested. This is definitely not a dynamic cap. It’s slow-sounding characteristic making it a poor choice for vintage restoration.

## Jupiter Beeswax

This has been a controversial capacitor since its birth. Beeswax impregnated paper was widely used as a dielectric in capacitors since before the 1940s’. Then it’s pretty much became extinct until Jupiter brought it into the 21<sup>st</sup> century! There are a number of shortcomings with beeswax. First, beeswax will easily melt from a solid state into liquid. Then, all hell will break loose when the capacitors’ dielectric stops functioning properly. Secondly, beeswax is a very poor dielectric with horrendous distortion and loss factors, by modern standards. However, some people argue that beeswax is very musical sounding. Jupiter sensed the market niche and brought back the dinosaur...

Here are some statements I copied from the manufacturer’s website, with my own highlights: “We believe the dielectric is the first area to be addressed in capacitor manufacture.” “Paper formulation and its handling were key, though impregnants were considered fundamental and **anti-oxidant** characteristics of impregnants were prized.” “**Beeswax naturally contains small amounts of propolis, which is a very powerful anti-oxidant, other properties include: anti-bacterial, anti-fungal, and anti-viral.**”

Hmm... Does the extremely powerful healing ability of beeswax also bless us with great sound?

It doesn’t.

As a matter of fact, in our money-no-object audio system, the beeswax cap failed miserably with its distorted sound and lack of dynamics. The “good news” for the manufacturer is that this distortion will make inexperienced listeners feel the cap is warm sounding, or “cure” the cold digital sound system somewhat. Unlike the three covered capacitors thus far, this capacitor is also not cheap at \$17 a pop. If price/performance factor is the focus of the review, it would inevitably be the worst in

the group. I strongly discourage anyone to use the cap. The dinosaur had its time and it doesn't belong to this new era.

### REL/PPMT

Reliable Capacitor is another giant among capacitor manufacturers. It gives generous discount on batch prices to manufacturers. Like Solen, it is omnipresent in hi-fi products. PPMT is one of their least expensive models among a dazzling array of lines.

Uninvolved sound. Otherwise, it is a balanced sounding capacitor with no other significant shortcomings and nothing exciting either. This cap is borderline Class E.

### *Class E*

### Russian Military Surplus Teflon Capacitor

I'm grading all these caps extremely carefully and stringently. The exceptionally well built Russian Teflon capacitor could receive a "B-" if not for the following shortcomings: 1. It is somewhat mechanical sounding. No matter how many more extra hours bombardment of white noise, this trait remained. 2. The bass lacks weight and impact somewhat, which may be a problem for most audiophiles. Otherwise, the capacitor is incredibly resolving! Only three (more expensive) capacitors are in the same league in terms of resolution. Also, this capacitor is exceedingly neutral and amazing dynamic. This darling may just be the holy grail for people looking for resolution, neutrality, and dynamics in the system.

Since this is former Soviet Union military surplus, it is widely available at eBay for \$2-3. Do not overpay. Also be aware this capacitor is huge in size and doesn't have traditional leads. Make sure that you have room inside the chassis.

This cap is the leader of the group and one of the leaders in terms of price/performance ratio.

### North Creek Music/Crescendo

It has a film and foil construction. According to the manufacturer, "Developed in 1995 and designed specifically to complement (via bypassing) other large value film-and-foil and exotic metallized capacitors, Crescendo bypass capacitors have a midrange and upper midrange is full and liquid while the top end is sweet and laid back." Now that's an honest assessment. The laid back characteristic, however, is not my cup of tea. Lacks dynamics compared with higher class caps. The tonality is excellent, however.

One must be aware that Crescendo was originally designed for use in speaker cross-overs. Some people whose ears I trust, are enthusiastic about the application, particularly when used as a bypass. I leave the experiment to you.

## *Class D*

### Mundorf/Supreme

Commonly known as M-cap Supreme, this German capacitor has a metallized polypropylene film, with exceptional low loss characteristics. According to the manufacturer, all M-caps feature 1. special induction-free winding technology: Two capacitor windings are interleaved so that their inductances effectively cancel each other out. These two windings are connected in series. This means that it takes two 2 $\mu$ F windings to make a single 1 $\mu$ F M-CAP SUPREME capacitor - the same amount that it would take to produce a full 4 $\mu$ F of capacity using conventional technology! 2. Best available materials: The polypropylene film used for the M-CAP Supreme has exceptionally low loss characteristics. 3. Sturdy plastic and aluminium cases: This prevents microphone effect feedback, thus protecting important signal details.

The M-cap Supreme is a true high-end capacitor. At any given day, it is a great capacitor by itself. It is rated class D here only because of the TOUGH competition. It delivers a big, open, spatial sound with great depth. The detail and tonality are very good. Relatively speaking, it lacks resolution compared with higher-class caps. It's one of the best buys among capacitors reviewed here.

### Mundorf/Supreme Gold/Silver

This top of the line Mundorf turns out to be somewhat of a disappointment. It is very expensive because "the metallization of the capacitor foil for the MCap Supreme Silver/Gold consists of 99.99% pure silver, to which 1% high purity gold is added. Gold alters the crystalline structure of the silver and maximizes its electrical conductivity."

All virtues of the M-cap Supreme remains in Gold/Silver, with everything better: better resolution, better dynamics, better musicality, better soundstage, etc. Unfortunately, it does not sound at par with its cheaper brother, the Silver/Oil. Consequently, it fails to make to class C although it is the leader of the group.

### Auricap

This metallized capacitor received a lot of hype after Jennifer at Jenna Labs rated it above \$260 "out of production" custom Teflon caps. An industry titan and LP guru who also uses the Teflon cap completely disagrees. Hmm... Unfortunately I don't have access to the out of production, hermetically sealed Teflon capacitor. Otherwise I would be glad to make my own judgement.

In any event, this capacitor has world-class neutrality, but not world-class resolution or dynamics. Two Teflon caps here: V-Cap and Russian military surplus simply kicks its butt in the latter categories. The capacitor is also admirably balanced. It's good in all other areas but not mind-blowing. In summary, it is the dream capacitor for manufacturers, with a relatively reasonable price.

Auricap used to have an exceptionally good price. However, with all the positive reviews and claimed price increase from their supplier, the cap has significantly

increased pricing over the last three years. Nevertheless, it still remains an excellent buy.

### Hovland Musicap

This film and foil capacitor is raved around the world in speaker application. Manufacturer's website claims "MusiCaps deliver fine dynamics, speed, focus, correct timbre and depth of field, and good inter-transient silence." All checked out to be true by the reviewer in signal coupling application. "By far the most musical capacitor available". Well, while this cap is indeed very musical, as the name suggests, it can't hold a candle to some of the better caps. Evaluating the Musicap right after the Audio Note Silver made this painfully evident. It was literally slaughtered by the ultra-expensive Audio Note in terms of musicality.

### Cardas Golden Ratio Capacitor

It features "two Golden proportioned dielectric layers, separated by a metallic coating which produces 'Retained Energy Scaling'. The amount and rate of energy released is split between the two dielectric receptacles in proportion to their constants. This composite dielectric eliminates the resonant signature of monolithic dielectric and provides constrained layer damping." Using golden ratio in construction is a brilliant idea. However, is it a pure marketing hype or with the true technical soundness?

The capacitor is very smooth sounding with good resolution and lots of musicality. The golden ratio winding apparently works. I applaud the manufacturer's website that remains factual throughout without significant overstatement.

### TRT Dynamicap

There are two versions of Dynamicap, one for electronics and the other for speaker crossover. We evaluated the electronics version. The manufacturer's website made a lot of broad, sweeping overstatements that their caps are more "dynamic", "musically", "natural", and "transparent" than "other caps" on one web page. Then another web page is dedicated to "Why do other caps have problems?" And so on. While this kind of writing and statement may draw masses, I was turned off quite a bit by it.

Fortunately, the Dynamicap actually delivers on a lot of its claims. It is full-bodied and produces lively sound. The dynamics are first rate, as its name suggests. With its competitive price tag, it is a good buy. However, is it "clearer, more transparent, airier, more open, and faster than any other capacitor" as suggested on the manufacturer's website? Absolutely not. It doesn't come close in any of the departments to the V-Cap, for example.

### *Class C*

Four out of five capacitors in this class are oil caps. Therefore we cover the singular difference first:



## REL/Exotica PCU

The Exotica line from Reliable Capacitors uses film and foil construction. The PCU uses copper foil as the electrode. It has a very musical sounding, first-rate resolution and dynamics, and liquid characteristics. Unfortunately, it does not sound as natural and harmonically rich as oil caps in the group, even though just by a slight margin. Otherwise, I will confidently declare this cap is the winner of the group. While its price is more expensive than Jensen's for example, you are rewarded with better dynamics and much better reliability, an important issue I will cover soon.

## **Oils**

The remaining four capacitors in the group utilized oil as dielectric, either in paper or impregnated poly. Notice there are only three capacitors better than these oil caps. Only the most critical listeners will find them having any wanting. Since all of them share common characteristics, I will go over the similarities upfront.

Oil, particularly paper-in-oil, is one of the oldest dielectric materials since the emergence of condenser. The other antique dielectric material – beeswax – didn't fare too well in this review. Would oil suffer the same fate? That's the question I had in mind after the disappointing experience with the beeswax caps. On the other hand, oil capacitors have been in continuous production since their birth. Would Darwin's theory predict the true survivor of the fittest?

The latter question received a resounding "yes" for all four capacitors. An old-fashioned dielectric inside does not doom the oil caps with colored and unresolving sound, as some people imagine. All of them are exceedingly neutral AND natural sounding. Although their resolution cannot compete with three better capacitors, they hold their ground steadfastly against pretty much all the other caps reviewed here.

One common misconception is that these oil caps sound warm. Therefore if anyone tries to put some of these babies into their digital and sterile sounding gears to take the advantage of warm oils, he may be very disappointed. None of the four oils here gives you warm sound. "They simply sound correct, with the harmonic richness of the live music." The statement quoted from Jensen's website summarizes the true sound nature of the oil capacitors.

Some people find oil caps dark sounding, I disagree with the assessment completely, at least for these four oils. Others argue oil caps have this "oily" feeling. While the argument may sound hilarious, I actually experienced it when I was still in my 20's, with hearing capability to 24KHz. Several years ago, I could easily tell whether oil caps were used in the signal path based on the oily signature. I cannot do it reliably now. The merciless aging process robbed me of any hearing above 19.5Hz and will continue its onslaught. I still remember in a New Jersey Audio Society meeting at the late Anna Logg's place, people were surprised that I could tell there were oil caps used in then brand-new BAT VK-75SE. Those caps later turned out to be the venerable Jensen.

Now the individual oil capacitors.

## Audio Consulting Oil Capacitor

This capacitor is made by the same Swiss company that makes the infamous low value power resistors with the most conducting metal – fine silver – for up to several hundred dollars a pop. For their oil capacitors, here are some manufacturer's statements I obtained from the company website:

- Machine wound and hand assembled in the homeland of watchmakers, Switzerland. Typically less than 10 % tolerance on C values.
- Oil filled metal can design resulting in high RFI/EMI rejection and efficient damping of vibrations (passive crossovers in loudspeakers).
- No deterioration or value fluctuation in high temperature environments like tube amps (tested during 56 days at 70° C).
- No PCB oil.
- Only paper dielectric (no mixed dielectric like paper/polypropylene).
- Special water repelling paint protects from moisture (built for tropical conditions).

It appears that the company really strives to make the capacitor reliable, while making it sound good. To me, this is a great thing. Unfortunately, I am unable to test the long-term reliability of the cap first hand. Oil caps, like their beewax cousin, are infamous for their unreliability. I will discuss the issue in details very soon when we talk about Jensen.

The Audio Consulting oil capacitor is the best in the class. The most resolved, most airy, most dynamic, most musical... The listed goes on and on. Plus it has the extra advantage of being able to sustain high voltage. Its physical dimension is nowhere near petite, so ensure you have room inside the chassis before placing orders. However, its real Achilles' heel is its price. At a princely \$65 each, only the Audio Note silver capacitor is more costly. Unfortunately, it is more expensive than the heavenly V-Cap Teflon at \$49.99. In a free market economy and free access to components, I don't see why any one should buy Audio Consulting over the V-Cap. Just hold your horses until I unfold the V-cap review very soon.

## Jensen Paper-in-oil Aluminum and Copper

The venerable Jensen has been in business since 1917. The company never stopped making oil capacitors even in the 1970's, when the high-end market was flooded with Japanese gear jammed with transistors and electrolytic capacitors. With the renewed interest in tube gear in the 1980's, Jensen's belief in oil capacitors was fully vindicated. The company has seen a surge in capacitor business, and now is the largest oil capacitor maker for high-end manufacturers.

For two paper-in-oil caps by Jensen, one uses aluminium as electrode and the other uses copper. They share some common traits as stated by Jensen:

- Terminal leads are pure silver axial type and are solder-sealed to eyelets in the end-discs. The terminal connected to the outer foil, the foil closest to the can, is always marked with a vertical line on the marking.

- Capacitors are encased in aluminum tube (hermetically sealed) with phenolic paper/rubber covers.
- Tolerance: 0.1uF or less is -20/+30%, greater than 0.1uF is -10/+20%.

For the two capacitors we are able to evaluate, the copper one is distinctly better than the aluminum model, providing better resolution and everything. Therefore, if your wallet can afford the extra few dollars, go with the copper. You may feel I'm terse with the description of Jensen's sound. That's because the common characteristics I wrote for this class of capacitors are based on Jensens. Strictly speaking, the aluminum Jensen should really be in upper Class D. I listed it here in recognition of its longevity.

Jensen also makes a model using silver foil. I'd LOVE to evaluate it. Unfortunately, we are unable to secure it for the review.

Jensen oil caps are bargains in the group. Very highly recommended. With a big caveat, however.

First of all, Jensen has just about the worst measurement among a dozen or so caps that come with published specification. They do measure horrible, by modern standards, according to a couple manufacturers I knew of. Well, since it's the sound that matters, the bench result has no bearing here.

The real problem is the reliability. According to Jensen website, these oil caps only have a measly 250 hour life at maximum temperature of 85°C. You may jump in with, "since the actual temperature inside a chassis is much lower than this, the life must be exponentially prolonged". Such is not the experience for several manufacturers using Jensen. I'm withholding their names here because I don't want them to be swamped with inquires about the Jensen reliability questions. If you are really interested in the horror experience of these poor manufacturers, just Google or a blog search at [audioasylum.com](http://audioasylum.com) and so on. Therefore, if you want to use Jensen, please make sure your chassis is cool inside, and inspect your Jensen visually at least quarterly, after one year. If you see deformation, discoloration, or oil creep, you should replace them immediately.

### Mundorf Supreme Silver/Oil

Per the manufacturer, "the Supreme Silver/Oil is and oil impregnated metallized polypropylene dielectric capacitor, with induction-free winding technology. High purity silver is used for the capacitor coating, and the winding is impregnated with a special oil developed in an exhaustive series of experiments and listening tests. Both of these features contribute to an even fuller and smoother richness and diversity." "This capacitor's ability to bring out the finest nuances and the most subtle distinctions make the music sound more alive and juicy, yet without unnatural emphasis of any individual effects."

This is an excellent capacitor with very liquid sound and world-class soundstage. Although it is not the most expensive in the Mundorf product line, it is the best sounding cap from this German company. It makes otherwise admirable M-cap Supreme and Supreme silver/gold comparably under-achieved. If the manufacturer's

statement is true: “This is also the first time that the benefits of oil-impregnated capacitor design have been successfully combined with the well-known long-term **stability** of metallised paper and internal series wiring for induction-free performance”, I’m sure other hi-end equipment makers will give their business to Mundorf from the (unfortunately) unreliable Jensen.

### *Class B*

#### REL/Exotica TFT

The sole capacitor in this class is the Exotica Teflon cap from Reliable Capacitors. The manufacturer’s website declares “We Make the Worlds the Best Caps”. This Teflon is probably the one they’re referring to. It is distinctively better than all other capacitors covered so far, but unequivocally “inferior” than the V-Cap and Audio Note Silver in the top class.

The first time I encountered this capacitor was three years ago. I was blown away by its neutrality, dynamics, and everything else. It was quite an experience back then. If this article was written at that time, I would simply declare this the best cap in the world, confirm the statement from the manufacturer’s website, and go on and on about how great the sound is.

I can no longer do that with the experience of two incredible capacitors this year. While the Exotic TFT is still a great product, for end users I urge you to spend less than 20% more to buy the V-Cap, which is similar sounding but better in every aspect. Frankly I do not see why anyone wants to buy the REL with the existence of V-cap, unless the less than \$8 difference matters a great deal. Manufacturers will probably stick with this cap given the generous quantity discount. As a matter of fact, I know at least one prominent manufacturer is doing this because of the good price offered to him by Reliable Capacitors.

### *Class A*

V-cap Teflon and Audio Note Silver are two very best capacitors in the world as of now. My enthusiasm for them cannot be understated. As a matter of fact, my heart started racing while writing this section, accompanying by dry mouth, sweaty palms, dilated pupils, and so on. When I heard them the first time this year, I literally had to pick my jaw from the floor afterwards, both times. The experience is equivalent to religious transformation in the Kingdom of High-fidelity! I wish I could have encountered them much earlier in my audio journey. I didn’t because the V-Cap Teflon is a brand-new product, by a very small company in 2004; and Audio Note Silver was way too expensive, even though it has been on the market for over a decade.

**I don’t see myself using any existing capacitors other than the V-Cap and Audio Note Silver in signal coupling applications in high-end gear from now on. That’s how great they are.**<sup>4</sup>

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<sup>4</sup> Both V-cap and Audio Note makes oil capacitors. We didn’t evaluate them because the minimum value of V-cap oil is 1 µf, and Audio Note oil had been made by Jensen until 6 years ago.

## V-Cap TTF

This is a relatively new product developed by Mr. Chris VenHaus. Chris made his reputation in the audio community by publishing various DIY cable receipts on his website and various blog forums. This author made several interconnects using very thin silver wires (0.005" or 0.0125cm) according to one of his "recipes". Till today, besides Omega Mikro cables, there is no other interconnects on the market I experienced that can excel over these home-brew cables. When I was made aware of the availability of the V-Cap early this year, I told myself I must include it in evaluation.

According to Chris, the V-Cap TTF Teflon film and tin foil audiophile capacitors are the result of an extensive research and development project by a team of world-renowned experts in electrical engineering, chemistry, materials science, and some of the top minds (and "ears") in the audio industry. While Teflon is the best dielectric material next to air and vacuum, it is not an easy product to work with. One of the biggest challenges with Teflon film capacitors is the permeations (microscopic pinholes) that form during the fabrication of the film, and when the film is stressed during the actual winding of the capacitor. The reason these permeations are a problem is because they have the potential to allow micro-arcing to occur between adjacent layers of the capacitor. The cumulative effect of this micro-arcing causes degradation of the capacitor's life and performance, in addition to a poor signal-to-noise ratio. The V-Cap design team found solutions to this challenge by sourcing Swiss-made winding machines and engineering proprietary bobbins that apply a light and ultra-stable tension to the custom spec'd teflon film during the winding operation. This greatly reduces the formation of permeations in the Teflon film, reduces microphonics, and provides an unsurpassed level of consistency and quality control. To take this a step further, the V-Cap engineers have also developed a new winding process called the Variable Stage Quadrant Dielectric™ (V.S.Q.D.). This unique winding process is a significant advance in capacitor technology because it virtually eliminates permeation alignments in three dimensions, ensuring an ultra-low noise floor, longer cap life, and highs that are extended, but without the fatigue or "tizziness" normally associated with capacitors of lesser quality.

Chris stated no expense has been spared to create these cost-no-object capacitors for the exacting audiophile. Now it is possible to get the smooth, liquid, and "musical" presentation of an oil capacitor, but with even better refinement, transparency and inner detail. Hear and feel true low frequency extension without any loss of control. Immerse yourself in a holographic soundstage emanating from a velvety black background, while enjoying the midrange liquidity and bloom coveted by oil capacitor aficionados. The V-Cap TTF's reproduction of a musical instrument's precise timbre must be heard to be believed. No detail has been overlooked or left to chance during the development and production of the V-Cap. Even the Teflon insulated, 18 AWG solid copper leads and epoxy end-fill have been carefully selected for the best musicality and detail.

Well, I was impressed, but with reservation, because of all too frequent overstatements from manufacturers. After I finally installed the V-Caps, I was completely stunned. Never in my lifetime did I experience or expect to experience such a great capacitor!

Then I felt a bit sad. As a journalist who would always love to first report new and exciting products, I was scooped by Mr. Arthur Salvatore, a famed audio veteran and blogger, who reported on the V-Cap Teflon just a few months earlier on his English website. While I'm comforting myself that I will still be the first to introduce this great V-Cap through the most prestigious and circulated Chinese audio magazine, the sense of loss of the opportunity of maybe-once-in-a-life-time is persistent.

Just how great does V-Cap TFTF sound? Besides fully concurring with the manufacture's statement, I'd like quote Mr. Salvatore's 12 commandments on why you must believe in the V-Cap:

- 1. They are the most neutral cap I've heard.**
- 2. They are the fastest and *most detailed* cap I've heard.**
- 3. *They provide the most natural texture, space and low-level details.***
- 4. They are the cleanest and purest cap I've heard.**
- 5. They are the most immediate and transparent cap I've heard.**
- 6. They are the most intensely dynamic cap I've heard.**
- 7. They provide the most separation and the least homogenization of any cap I've heard.**
- 8. They provide the most intelligibility of any cap I've heard.**
- 9. Their soundstage is the most focused that I've heard.**
- 10. They have the tightest, cleanest, most natural and most impactful bass I've heard.**
- 11. They have the most extended frequency extremes I've heard.**
- 12. They have the lowest "noise-floor" of any cap I've heard.**

Readers may notice some of the sentence or words are italic. It means I have difference conclusion on these statements. Remember, Mr. Salvatore never had chance so far to evaluate the ultra-expensive Audio Note Silver capacitor that turns out to be the nemesis of V-Cap. The reduction from 12 to 10 commandments is still enough to elevate Chris VenHaus, the father of V-Cap, to the status of god in the audio kingdom. That's how mighty the V-Cap is.

Besides the incredible sound, Chris declares the V-Cap TFTF can also handle much higher temperatures than most other caps, making them significantly more reliable in the relatively high temperatures often found inside vacuum tube amplifiers. As a matter of fact, Chris is so confident in the reliability of his V-cap that he provides a life-time warranty to the original purchaser. Furthermore, V-cap is about the same price as REL Teflon, given the discount Chris is providing when people purchasing at least two of the same values.

One thing about the V-Cap TFTF readers must be fully aware of is its incredible lengthy break-in process. Not only it takes about 400-500 hours to break-in, but also the sound of V-cap can be incredibly unpleasant before break-in. Without going into details, an immature V-cap Teflon is capable of bringing you into a journey to sonic hell. You are warned!

When I was just about to declare the V-Cap is the best capacitor in the world, there came the Audio Note Silver capacitor.

## Audio Note/Silver

According to the manufacturer, the silver foil capacitors have 99.99% pure silver foil, 20 strand silver litz leadouts and solid non-magnetic copper case. They use a fine mylar film instead of a paper in oil dielectric, and have found this to be the best compromise between sound and reliability.

Nevertheless, the very first thing just about everyone notices about the Audio Note Silver is its extraordinary price.<sup>5</sup> Therefore, even though the capacitor has been on the market for over a decade, few ever actually purchased it, let alone seriously evaluated the products. To make matters worse, there is a lot of confusion among the Audio Note UK and Audio Note Japan.

The Audio Note Silver capacitor we are evaluating is from Audio Note UK, not from Audio Note Japan. Here is some price information for the silver capacitor in the North American market as of December 2005:

0.10 $\mu\text{f}$	<b>\$155.80</b>
0.22 $\mu\text{f}$	<b>\$202.95</b>
0.47 $\mu\text{f}$	<b>\$332.10</b>
1.00 $\mu\text{f}$	<b>\$481.75</b>
2.20 $\mu\text{f}$	<b>\$902.00</b>
3.30 $\mu\text{f}$	<b>\$1,389.90</b>

Too expensive? Try the price from Audio Note Japan. Here is price information for Audio Note Japan Silver capacitors, advertised on *Sound Practices* back in **1992**:

0.05 $\mu\text{f}$	<b>£270.00 (about \$475 in December 2005)</b>
0.10 $\mu\text{f}$	<b>£540.00 (\$950)</b>
0.15 $\mu\text{f}$	<b>£845.45 (\$1,488)</b>

Price for other values? Too scarily expensive to advertise. Remember we are talking about 1992 monetary value here 13 years later. Why the huge price differences between the ones made in UK and Japan? Apparently the obsessive Japanese is insistent on making the capacitor all by hand and under microscope. Even the silver foil used in the cap is hand-drawn. Is the Japanese version better than the UK version? This is the answer I may never find out. And I may not want to find out given how much more expensive the Japanese version is. Remember my friend has the original Japanese silver capacitors in his ultra expensive Audio Note 211 monoblocks. We didn't remove them for comparison because: 1. The de-soldering and re-soldering processes inevitably degrades the sound 2. Even if we find the Japanese version is better than the UK version, can we imagine the sound improvement can justify the extraordinary price difference?

While Peter Qvotrup at Audio Note UK has been working hard to make the price of silver capacitors much lower, the current price is still not exactly affordable, at \$155.80 each for 0.10  $\mu\text{f}$ , this is the most expensive capacitor by a large margin. The

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<sup>5</sup> That's the very reason why Arthur Salvatore never evaluated the capacitor.

sales tax on it would be more expensive than about half of the capacitors reviewed here.

**However, it is worth every penny in a high-end system!**

Simply put, this is the *capacitor with most detailed sound, the most natural texture, space and low-level details*. The details come out of the incredible complex and rich harmonics that even V-Cap cannot match. In addition, this capacitor has the indescribable musicality that no other capacitors come close. Some readers may point out that since the experiment platform is a copy of Audio Note M7, the Audio Note silver capacitor must have the unfair disadvantage of build-in synergy. Well, I tried the silver cap in another modern preamp, the magical quality remained.

For me, one of the most reliable ways of identifying a world-class audio product is emotional response. If I'm emotionally moved by the sound, then it must be a great product. The reverse is not true though as I may be in a bad mood and such. I was literally emotionally choked right after the silver capacitor was installed.

While V-cap excels in 10 other areas as outline by Mr. Salvatore and hence has the most intelligibility, the Audio Note Silver, without doubt, has the most sensuality. To lots of the people, this is enough reason for them to feel Audio Note has the world's best capacitor. While one wins my brain, the other one holds my heart. If the V-Cap is the Ferrari in the cap world, the Audio Note Silver must be the Rolls-Royce. One is exciting, and the other is luxurious. Make your pick.

It is foreseeable that readers want me to pick a winner between the two. It is a really tough call that ultimately depends on your very own system! A safe bet would be use at least two Audio Note caps in your high-end stereo system to take the advantage of its magical quality, and the rest with V-Caps. Ultimately, I give the crown to V-Cap as it is the most balanced and versatile capacitor ever made.

**Conclusion**

This is an incredible journey with 21 capacitors. For budget-constrained consumers, the Russian Teflon is a good pick; for excellent performance with reasonable price, you cannot go wrong with Jensen and M-cap Silver/Oil. For audiophiles who take no compromise and can afford the price, Audio Note Silver and V-cap TFTF should be your only choices.



厂商/电容品牌型号	产地	电容介质	耐压参数 (DCV)	美国市场零售价	网址
Audience/Auricap	美国	Metallized Polypropylene	600	\$14.76	www.auricap.com
Audio Consulting	瑞士	Oil, Film and Foil	1250	\$65.00	www.audio-consulting.ch
Audio Note/Silver	英国	Mylar and Silver Foil	600	\$155.80	www.audionote.co.uk
Cardas/Golden Ratio	美国	Metallized Film	600	\$16.44	www.cardas.com
Hovland/Musicap	美国	Polypropylene film & Foil	600	\$11.52	www.hovlandcompany.com
Jensen/Aluminum	丹麦	Paper-in-oil and Aluminum Foil	400	\$12.75	www.jensencapacitors.com
Jensen/Copper	丹麦	Paper-in-oil and Copper Foil	630	\$19.00	
Jupiter/Silver Lead	美国	Beewax/Paper and Aluminum Foil	600	\$17.00	www.jupitercondenser.com
Mundorf/Supreme Silver/Oil	德国	Metallized Polypropylene, Oil	1200	\$20.40	www.mundorf.com
Mundorf/Supreme Silver/Gold	德国	Metallized Polypropylene	1200	\$32.90	
Mundorf/Supreme	德国	Metallized Polypropylene	1200	\$10.00	
North Creek Music/ Crescendo	美国	Polypropylene Film and Foil	800	\$8.95	www.northcreekmusic.com
REL/PPMT	美国	Metallized Polypropylene	600	\$8.09	www.capacitors.com
REL/Exotica TFT	美国	Teflon® and Tin Foil	600	\$42.38	
REL/Exotica PCU	美国	Polypropylene Film & Copper Foil	600	\$30.32	
Solen/SM	法国	Polypropylene Film & Tin Foil	630	\$3.95	www.solen.ca
Solen/PPE	法国	Metallized Polypropylene	630	\$1.35	www.solen.ca
TRT/Dynamicap	美国	Metallized Polypropylene	425	\$11.95	www.trt-wonder.com
V-cap/TFTF	美国	Teflon® and Tin Foil	600	\$49.99	www.v-cap.com
Xicon	中国	Metallized Polypropylene	630	\$0.73	www.mouser.com/xicon
Russian Military Surplus	前苏联	Teflon® and Tin Foil	500	\$2-3	www.ebay.com