Heat Treat News

Rolf Terjung/Graphite Materials GmbH September 2015

We are pleased today to have an inteview with a very interesting fellow by the name of Rolf Terjung of Graphite Materials in Germany.

1. For years I have been fascinated by Carbon composite (C/C) fixtures for furnaces because of the fact it's strength and ability to withstand high temperatures seems to be out of all proportion to it's size and weight. Can you tell what makes this possible?

"To cut a long story short the strength of carbon fibers is based on the graphitic covalent structure which is highly orientated in fiber direction. The covalent bond is the strongest link between tow atoms we know. As an example picture the diamond which is one of the hardest material by nature due to the covalent bond. The thermal withstand simply relates to further exceptional material properties such as the negative CTE and high thermal conductivity. With raising temperature the fiber length shrinks but the diameter grows. For industrial plate stock the CTE turns out to be almost "zero". Combined with a high thermal conductivity the material shows almost no thermal stress behavior. Finally the low density of about 1.6 g/cm³ (0.058 lbf/in³) compared to about 8 g/cm³ (0,29 lbf/in³) for HT-metal is responsible for the proportion of size to weight. High temperature strength combined with low density results in stiffness. A C/C fixture weighs about just 20% of the equivalent HT-material fixture carrying the same load."

2. Very briefly what is involved in the manufacturing process?

"We start with the engineering which means the technical design and simulation of thermal and mechanical load patterns. The result is fixed in a blue print. On the shop floor plate stock material is cut to size by water-jet-cutting, grinding and milling. Diamond coated tools with special cutting edges come into operation with the milling process. At this point experience and know-how regarding milling parameters makes the difference regarding cost and quality."

3. I understand the advantages but what about the disadvantages in particular the cost-how would a typical fixture made of graphite compare to one made of HT material as an example?

"From my point of view we face two disadvantages due to the material characteristic: Oxidation beyond a temperature of 350°C (662 F) in oxygen containing atmosphere and the contact reaction (C/C with Metal) in vacuum or inert gas beyond 1050°C (1922F). To avoid oxidation CC-fixtures basically can only be operated in vacuum or inert gas furnaces. The contact reaction is no longer a problem as the industry as well as we have engineered low cost and long lasting industrial solutions easy to handle. When it comes to cost we can prove by simple calculation that amortization is much less then the life time of a conventional HT-material. We looked into a clients process with a return of investment within 12 months. The winning arguments read as: more load per fixture, shorter process runs (heating/cooling), from manual to automated processing and lower energy use. On top one worker can easily handle the fixture by muscle power. In one word: significant increase of productivity which pays off in profit immediately."

4. I am assuming that you can only justify the cost in high end applications such as vacuum carburizing. Is this a fair statement?

"Yes and No. We´ve successfully introduced CC-fixtures in different heat-treatment processes with gas and even oil quenching. Vacuum carburizing is of course one of the processes but also the vacuum brazing. Any heat treatment process beyond 1000°C in vacuum or inert gas has the potential for C/C fixtures. Distortion of the component due to fixture deformation of HT-material produce rejects and waste. One of the unbeatable arguments of CC-fixture is the non-distortion and hence no costs for straightening. Basically the process stability level shoots through the roof. Another brownie-point to be added to the factors already mentioned under item 3)"

5. This is part statement part question. As a North American I am well aware that we think more short term. In other words we want a profit today not 10 years from now which makes it harder to justify a high initial for fixturing even if it does provide far longer life. Is this an attitude that you run across very often or is it very unique to North America?

"Yes we came across this argument but no longer very often. The "winning arguments" already mentioned in question 3) provide a "profit" from the first time you put C/C fixture into operation. On top the level of process stability achievable makes live much easier considering planning, quality control and delivery time. On one hand we can look back to more than 15 years of successful experience which has spread around in the HT-family in Europe. On the other hand global competition forced the HT industry to examine the cost of the entire production process carefully. As a result among others fixtures have been identified with a significant cost potential. With a view to total cost and facts such as the "carbon food print" CC-fixtures are becoming a must-have."

6. What percentage of the market, either in Europe or in other areas, is graphite as opposed to more traditional materials?

"I have no official data to present. But I guess CC has gained about 10% of the potential market. Don´t get me wrong. CC won´t replace traditional HT-material. Both concepts have its qualification in the industry. But the more the power to compete is the driving force the more CC-fixtures come into place. Please notice we have already engineered CC-fixtures to carry a single piece weighing 5000 kg (11023 pound). The HT-family is a traditional industry used to work with durable massive HT-fixtures. There is some doubting we have to overcome with our arguments."

7. All of my questions to you have been more focused on fixturing than other furnace components. Where else in the heat treating industry do you see demand for your products?

"Our portfolio covers Graphite, Carbon/Carbon and fiber insulation products. If you look into the vacuum or inert gas furnace from cage to hot zone we provide the insulation (soft felt or rigid board), surface protection (foil or C/C-shield), heating systems (connectors, rods, electrodes, etc.), bars and C/C fixtures. We´re proud of having a skilled engineering and production team which is thrilled by bringing smart ideas into winning products for clients. As an example we developed a fixing system for the board insulation (cage and door) which stays back in the board. Hence the heat loss by the Molly pins (feed through from hot zone to cold wall) totally disappears. It has proven performance for several years even in gas quenching furnaces up to 10 bar. We optimized various heating systems by combining material – engineering and production know-how with the effect of longer life time and higher productivity. We gained our clients trust and based on that we are servicing the HT-industry since 2012 with entire vacuum furnace hot zone upgrades and replacements."

8. Is the graphite industry a competitive one or do you see just a couple of suppliers?

"The industry is competitive although there are just a few highly skilled suppliers. As I already mentioned technical know-how and trust is important in that business as carbon based material all looks black. The market became significantly competitive when the solar hype cooled down in 2012 with the consequence of too much stock material globally hanging around. Generally speaking we take it as a challenge: competition gives birth to new ideas and drives innovation."

9. So how did you come to end up in this industry? What is your background?

"Good question as it is still a niche industry. My educational background is powder metallurgy and engineering ceramics. The element "C" is a monoatomic ceramic. So I came across carbon and graphite by education. As a "hands-on" man I preferred to work in the industry after my PhD. When we started Graphite Materials in September 2000 as a trading company I always dreamt of my own machine shop which came through in 2008. Since then we established the entire machine shop service on about 3000 sqm with a total staff of 30 people. The customer base covers Europe, USA and Mexico."

10. What are your predictions for the heat treating industry in general in a world full of turmoil? Are you optimistic about the future? Reserved or pessimistic?

"I am optimistic due to my personal settings. Heat treatment is a fascinating but complex subject full of possibilities. I have no doubt what so ever turmoil shakes the world this industry stays economically well established and will discover new application areas. We´re ready to be at your side."