

# New core technology for light metal casting

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**Abstract – A new approach for lost cores for light-metal casting was developed based on the substitution of sand by hollow additions with specific compression strength. The suitability of phosphate, gypsum and cement binders for such cores was tested. Test parameters were the molding behavior of the cores, their bending strength, surface quality and easiness of demolding. The core behavior during the casting process was evaluated using aluminum casting experiments performed in permanent molds. Feasibility could be shown for phosphate and cement binders, the latter having a higher bending strength.**

**Key Words – lost cores, hollow microspheres.**

## I. INTRODUCTION

Lost cores are used to generate cavities in casted components. They have to withstand the thermal and mechanical loads during the casting and should not release gases which deteriorate the casting quality. Afterwards, the cores have to be removed from the interior of the component ('demolding'), which is conventionally achieved by a thermal breakdown of the binder. In aluminum casting most inorganic binders exhibit a residual core strength which is too high for easy demolding. Furthermore, sand grains can interlock in narrow cavities which have limited accessibility for cleaning measures. In order to approach this problem a new core material and demolding concept have been developed [1]. It is characterized by the substitution of the sand filler by hollow filler material with specific compression strength. After the casting the core is subjected to high water pressure leading to collapse of the hollow filler, loss of the structural core strength and a reduction of the core volume. The residues of the core can be flushed out easily. The aim of these investigations was to prove the applicability of 3 different binder systems (phosphate binder, anhydrite gypsum and Portland cement) and the determination of suitable core compositions. Main test parameters are molding behavior, surface appearance,

bending strength, demolding and casting behavior.

## II. MATERIALS AND METHODS

Porous aggregates up to 85Vol.-% (related to the mixture) of 3M-S60HS micro hollow glass spheres and Fillite Omya 160W were used and varied individually for each binder (MgO/MAP, anhydrite gypsum with 1% K<sub>2</sub>SO<sub>4</sub> and Dykerhoff CEM I 42.5 R – SR 0/NA cement with additions of micro silica and superplasticizer). Bending tests were carried out with 10mm x 10mm x 100mm samples on a test unit Innowep-Tenso with 2mm/min and bending specimen fracture surfaces were used for SEM investigations. Collapse behavior was tested with a cold-isostatic press (EPSI, 3000bar). Aluminum test parts with cores were casted for the evaluation of the interaction of core and melt and their demolding behavior.

## III. RESULTS AND DISCUSSION

MgO/MAP-bound specimens were easy to mold and showed a good surface quality as well as a good contour reproduction. The addition of hollow spheres led to a bending strength from 1.0MPa-2.0MPa. This value is already close to typical bending strengths of cores with inorganic binders (1.3-4.0MPa) [2]. A complete structure collapse could be obtained for cores with 62Vol.-% S60 hollow spheres (Figure 1). In contrast, Fillite spheres did not lead to good collapse behavior.

The use of gypsum anhydrite binder in combination with hollow glass spheres led to very long curing times of several days. No combination showed acceptable strength and collapse behavior at the same time.

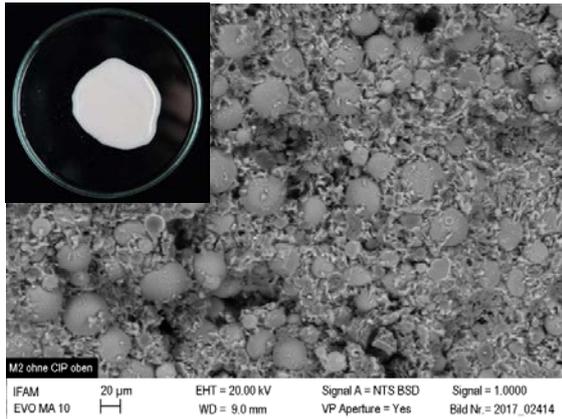


Figure 1 Structure of core made from MgO/MAP with 62Vol.-% S60 hollow spheres; top left: after water pressure of 3000bar

The molding of the cores with cement binder was generally easy combined with a good surface quality. The volume content of hollow spheres S60 should be 75Vol.-% to achieve a collapse effect. Adding of  $\leq 10\text{wt}\%$  micro-silica or 0.5wt% superplasticizer (related to the cement mass of the mixture) enhanced the bending strength. Higher contents led to inferior surface quality and de-mixing effects.

The bending strength of cement bound cores was between 2.5MPa and 5.5MPa and depended on sphere content and amount of additions. Micro-silica which are known additions for high-strength concretes [3] increased strength only when the addition was  $< 10\text{wt}\%$  (Figure 2). The bending strength for cement bound cores with hollow spheres as filler was on the same level as for typical sand cores [2]. For easy demolding a S60-sphere content of 75Vol% was needed. For cores with 75Vol.-% S60 the best combination of bending strength (3.2MPa) and demolding behavior was found for 5wt% micro-silica and no superplasticizer addition.

The casting experiments (done only with phosphate and cement binder cores) showed good core stability and no deleterious reactions between core and aluminum melt. No outgassing for phosphate bonded cores and slight outgassing for cement bonded cores were detected. The demolding (after CIP) was performed by simple pressure-less washing and only very small core residues were found in narrow internal edges of the casting component.

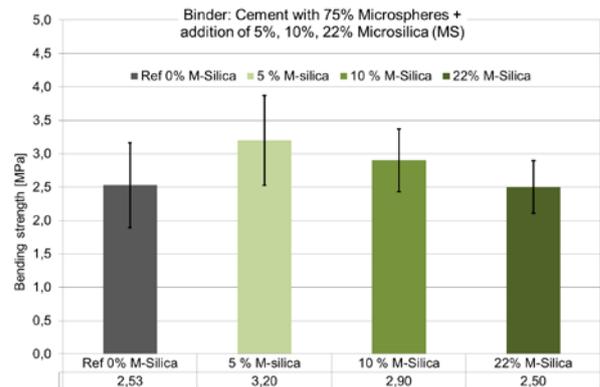


Figure 2 Bending strength of cement bound specimens in dependency on the micro-silica content (75Vol.-% S60, drying temperature 110 °C)

#### IV. CONCLUSION

The suitability of phosphate and cement binders for the new concept of collapsible cores could be proven. In comparison gypsum anhydrite led to insufficient core strength and demolding behavior. Whereas phosphate binder showed the best surface quality and demolding behavior, the cores with cement binder offered superior bending strength.

#### ACKNOWLEDGEMENTS

The authors thank Maike Peters and Frank Hlawatsch from Amtliche Materialprüfungsanstalt Bremen for helpful discussions and providing materials.

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